McGraw-Hill
Publishing Company, Inc.
James H. McGraw, *President*
Mason Britton, *Vice-President*

POWER

Editor
Fred R. Low
General Manager
Irving Fellner

Volume 68 New York, September 25, 1928 *Number 13*

Give Your Power Engineer a Chance

IN the last foreword I ventured the opinion that of the complaints of the power-plant engineer of low pay, diminishing opportunity and lack of appreciation, the latter had the most cogency.

It is true that even those of the so-called engineers whose functions are wholly mechanical and manual receive less pay than workers in other mechanical trades. There is too much competition in that class of labor.

Opportunities for the mediocre man are diminishing. Mediocre men in charge means mediocre plants, and the mediocre plant cannot compete with the central station.

To the man who is alive to what is going on about him, who knows the possibilities of improved methods and apparatus and how to realize them, there are greater opportunities than ever.

Because there are a multitude more things that can be done to effect savings.

The thing that stands most in the way of the realization of these opportunities is lack of confidence in and appreciation of the capabilities of the power-plant manager who is a real engineer.

A specialist is put in as production manager. He is given a free hand, furnished what he asks for and held responsible for results.

The power engineer is, or should be, no less a specialist in producing the services for which the production manager calls: power, electricity, heat, refrigeration, compressed air, hydraulic pressure, hot and cold water and what not.

And when he knows that it can be done cheaper and better than he is doing it and the executives will not listen to his suggestions and are unable to comprehend or unwilling to investigate the possibilities of modern improvements and, in some cases, even to keep the plant up to its antique standard, it hurts.

In watching the use of the steam and other services that he supplies, the power engineer frequently sees where the specifications could be improved upon and wastes be avoided in the application of the services that he has furnished.

Many successful production managers have come up through the power plant. When one of them offers a suggestion or presents a need, give him at least an attentive hearing. He lives with your plant and maybe knows something about it.

F. R. Low

POWER *Stands for . . .*

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**

One Way to Obtain the Best

THE average individual hesitates at digging down into his jeans to the tune of four or five hundred dollars for some coveted article. It may be of superior quality and workmanship, but a slightly inferior article at ten or twenty per cent less will tempt him strongly. However, if he be permitted to make payment in a number of installments over a reasonable period, price loses its importance and he will invariably select the better article.

The analogy holds, in a larger sense, with mechanical equipment. Many equipment manufacturers complain bitterly of the prevailing buyer's market with its insidious price cutting. Some are bold enough to advocate selling on quality alone regardless of price, but few are so favorably situated as to be able to practice it. However, if it were applied in connection with installment selling, better equipment would less likely be penalized because of price.

It is to the purchaser's advantage to install apparatus that not only carries superior workmanship but also embodies a background of development and manufacturer's prestige. If the savings will pay for the equipment in a few years, the higher price loses its significance. It will be more than offset by greater reliability and is likely to prove the cheaper investment in the end.

When Guessing Stops, Profits Expand

YEAR after year the evidence keeps mounting that good instruments, intelligently used, are as safe and profitable an investment as can be made. Public utility power stations learned this lesson long ago. Industrial plants are still trailing behind, although the exceptions are numerous and notable.

If there are any doubting Thomases left, they should read the leading article of this issue. The author credits instruments with a yearly saving of $10,600 in the plant of the Merrimac Chemical Company at North Woburn, Mass. This is probably an underestimate.

Action based on the readings of flue-gas thermometers, CO_2 recorders, steam meters and steam-flow air-flow meters raised the efficiency of the boiler plant from seventy-two to eighty per cent, saving eight thousand dollars yearly on the coal bill. Use of instruments to check the steam rate of the main turbine led to an overhauling which cut the steam consumption three pounds per kilowatt-hour, saving another $2,600 per year. In addition a gross yearly saving of $7,500 was made by changing the steam pressure on the air compressor and stopping wastes in the transmission and use of compressed air. Although these changes were a direct result of the use of meters, no part of this $7,500 is included in the reported total savings of $10,600 for reasons explained in the article.

If this were an isolated example of the money-saving possibilities of instruments, it would not be so impressive. It is significant because it is in line with the experience of many other plants where instruments have been installed for intelligent use and not merely as parlor ornaments.

The Gray-Iron Foundry Turns to Science

COMPETITION is something more than the life of trade; it is a vital force in promoting the application of science to industry. The latest example is the establishment of an industrial fellowship on foundry practice at the Mellon Institute of Industrial Research in Pittsburgh.

Scientific methods have encountered least opposition in new industries such as the manufacture of automobiles, airplanes and synthetic chemical products. Ancient industries, such as tanning and gray-iron casting, have, as a rule, tended to look with disdain on the man of science and smile at his offers of assistance. "We have been doing this job for years; what can you tell us?" has, until recently, expressed the attitude of most manufacturers in these lines.

Not so today. The stern operation of economic law has done what no amount of argument could have accomplished. The shock of bitter competition has caused a new light to shine in old places. These same industries now seek the elixir of life at the fountainheads of scientific and industrial research.

Only last year the tanning industry, hard pressed by the competitive products of synthetic chemistry, raised leather and tanning research to a higher plane and arranged for its substantial endowment. The foundry industry has encountered similar competition, first from stampings and drop forgings, and now from welding. This has forced action that might otherwise have been

delayed indefinitely. The Whiting Corporation, manufacturer of foundry equipment, has sensed the fundamental needs of the situation and taken the initiative in founding the new fellowship of foundry practice, assigning to it Dr. Edward E. Marbaker, a trained chemist with long experience in metallurgical research.

Power, which has followed with keen interest and sympathy the remarkable expansion of welding, extends to Doctor Marbaker and the foundry industry its wishes for the greatest possible success of this intelligent venture. It is sure to pay its way many times over, if history is any guide. Perhaps the foundry, by improved methods and products, can hold some of the ground threatened by welding and other processes. In any event each will ultimately be applied where it is economically most suitable and industry in general will profit by the competitive advances on both sides.

Competition, wasteful in some of its aspects, is becoming more and more a powerful factor in promoting the general prosperity through the increased application of science to industry.

Pinch Hitters or Regular Players?

SOME plant engineers use their spare equipment as a pinch hitter, something to serve in an emergency, while others make the spare apparatus a regular player on the power-machinery team. The difference in the two methods of operation is marked. In the first, machines are frequently operated with little attention except when something happens. In the latter, the spares are used to prevent trouble that would cause shutdowns, expensive repairs and production losses.

A visit to a plant of the first type found the maintenance superintendent not knowing just how the machines were taken care of. There was no established procedure for handling this work. No attempt was made to locate the little defects before they developed into faults that would cause a shutdown. Equipment was looked after in a hit-and-miss way, and when a machine failed a spare was put in its place. A visit to the motor repair shop showed a number of expensive repairs under way, that could easily have been avoided by the simple expedient of checking up the air gaps of the motors. The admission that about twenty per cent of the motors in the plant failed each year was a sufficient indication of the futility of this kind of maintenance.

A visit at another place found the engineer in touch with everything in his plant. All equipment was regularly cleaned and inspected and carefully checked. Spare equipment went into service regularly to allow taking machines to the shop for thorough cleaning and overhauling. Recording meters were used on all the main units, and the records were carefully studied for indications of unusual operation. In this plant there was no guesswork; those responsible for operation knew the condition of every machine and made it their business to have it ready for service whenever it was wanted. An inquiry about the reliability of the plant brought the answer that it had been one hundred per cent for its six years' operation. No major repair jobs had been encountered.

In this plant the spare equipment was used to take the element of chance out of operation, where in the other it was something to gamble with. In one, maintenance costs were low and operation certain. In the other the costs were high and operation doubtful. Don't let the spares in the plant be pinch hitters. Make them regular players.

Mills for Pulverizing Coal

TWO popular forms of mill for coal pulverization are the screen and the air-separation types. These names designate the methods used to classify the material leaving the mills. Screen mills operate satisfactorily with dry material, but may clog up with damp coal. The air-separation type also may function badly on wet coal if not properly vented. When vented, the dust from such vents may prove difficult to handle.

Several plans have been developed to carry out the drying of the coal in the air-separation mill itself by circulating heated air through it. If this air cannot be delivered to the furnace, a small quantity of highly preheated air may be used. However, if the air from the vent can be used as primary air to the burners, as is now done in several plants, then large volumes of preheated air may be used in the mill. This method eliminates coal driers and simplifies and cheapens the layout. Reports indicate that the temperature of the parts of the mill are little higher than when no heated air is used, hence lubrication troubles have not increased.

Most American plants are built with the suction fan on the air separation system placed to draw air through the mill and deliver it to the cyclone. This fan handles both coal dust and circulating air. The abrasion of the coal dust rapidly wears out the fan blades. In Europe this fan has been placed on the return pipe. It draws air from the cyclone and forces it through the mill. The air at the fan carries only some very fine dust that has not been separated in the cyclone. Fan maintenance is therefore markedly less, and the fan is said to require less power than the usual arrangement.

The use of air drying in the pulverizing mills and of the vent as primary air will greatly simplify pulverized-coal systems, but will require that the mills shall be placed beside the boilers. If a unit system is used, the drying air will, of course, be delivered from the mill direct to the furnace.

These trends of development are in the right direction. Industry wants a simplification and reduction of cost of pulverized-coal systems.

INSTRUMENTS *Save Money*

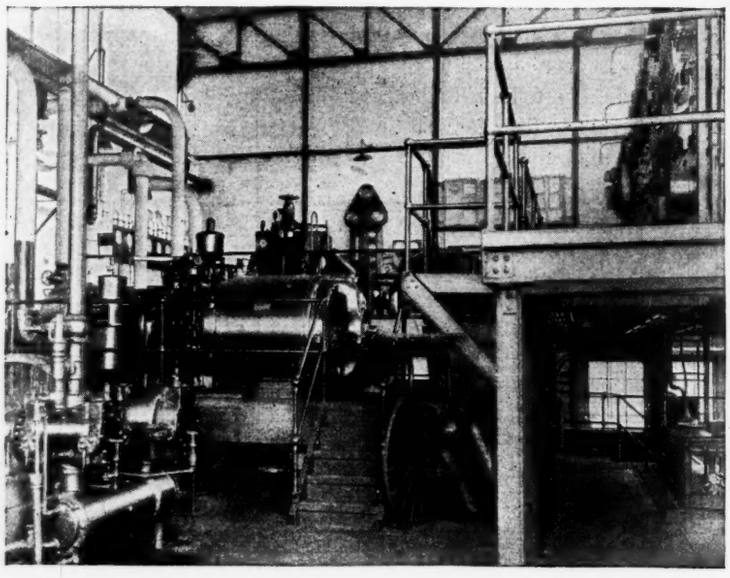


Fig. 1—The Merrimac turbine room

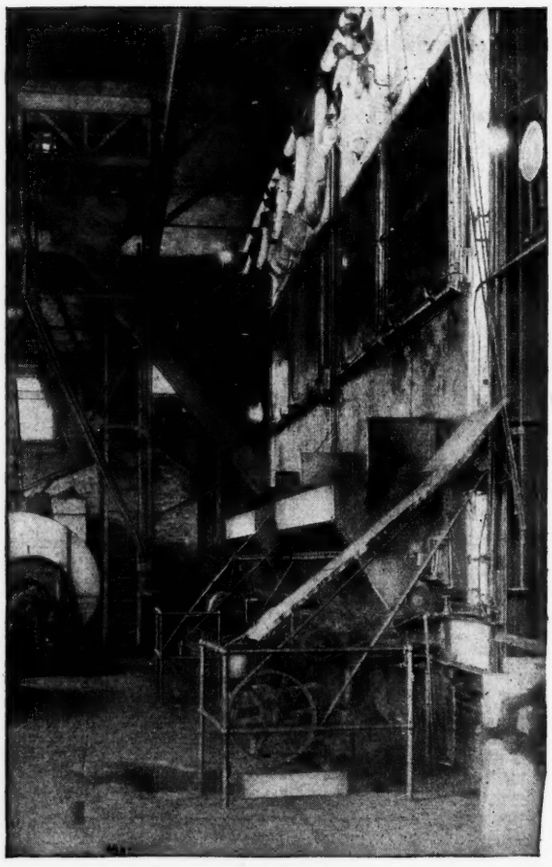


Fig. 2—The boiler room

$10,600 Saved Yearly in a Chemical Plant

By W. H. Scott

Chief Engineer
Merrimac Chemical Company

THROUGH the installation and intelligent use of flue-gas thermometers, CO_2 recorders and steam-flow air-flow meters and steam meters the efficiency of the boiler plant of the Merrimac Chemical Company has been raised from 72 to 80 per cent. In addition the steam rate of the turbine has been decreased.

This company has two plants, one of which is in North Woburn, Mass. There are four 2,500-sq.ft. horizontal-drum water-tube boilers, each of which is equipped with superheaters. Steam pressure is carried at 205 lb. gage. One of these boilers is not in use, while two are constantly on the line, with the fourth as a stand-by. The boilers have underfeed stokers and the two forced-draft fans are motor driven. On the pressure side of the fans is a damper automatically operated by the steam pressure.

The plant contains two turbine-generators, one a 625-kva. bleeder type and the second a 500-kva. straight condensing unit. The second is used only when the bleeder unit is down for repairs. Both operate with 200 lb. initial pressure and have jet condensers.

To supply air used in the factory, one compound and two single-stage compressors are used.

The metering and accounting system was the same, practically, as at present, as was also the general plant layout.

Two years ago the company was obtaining an over-all boiler efficiency of 72 per cent. Up to that time no effort had been made to check the performance of the separate boilers.

The cost of compressing air was high; for, in order to increase the efficiency of the bleeder turbine, low-pressure steam from this turbine was used to drive the compressors. The steam consumption of the latter was naturally high, resulting in a considerable loss of exhaust steam through the atmospheric relief of the open-type feed-water heater.

A beginning was made of weighing the coal to each boiler, and it was found that No. 3 boiler operated at 75.8 per cent efficiency, No. 4 at 70.4 per cent and No. 1 at 63 per cent. To assist in maintaining combustion at the highest possible level, a new Republic CO_2 indicator and two Foxboro recording flue-gas thermometers were installed to replace older types.

Since No. 1 boiler was giving the lowest efficiency, all its tubes were bored, and the brickwork was repaired so that all air leaks were stopped. The superheaters were cleaned and the under-fire dampers adjusted to operate smoothly. The stack damper was then connected to the regulator which controls the damper on the pressure side of the fan, so as to work automatically with the pressure change.

The boiler efficiency on the next run went up to 68.7 per cent. During the next three runs only the bottom rows of tubes were bored between runs, resulting in efficiencies of 65.6, 65.3 and 66.3 per cent.

After shutting down No. 1 boiler, a Bailey steam-flow air-flow meter was installed, with the result that on the next run the efficiency went up to 68.6.

But as this was far below the efficiency obtained with No. 3 boiler, all the tubes of No. 1 were bored at the end of the run.

Considerable trouble had been experienced with coal siftings in the stoker air chamber, and a shutdown of from ten to fourteen hours was needed during a run to clear the chamber. The coal siftings were for the most part burned and of little heating value. To overcome the sifting trouble, a baffle was placed in the air chamber and the doors were placed on hinges to make cleaning easier. As a result the chamber is cleaned every day and the coal has lost little of its heating value. On the next run a 71.1 per cent efficiency was shown. But by reboring only the bottom row of tubes, the efficiency on the next run dropped to 67.7 per cent; part of this drop was attributed to the use of coal that had lost some of its heat value by prior spontaneous combustion.

After this run the boiler setting was carefully measured to ascertain if any difference existed in the construction of the three boilers. While this was being done, it was found that the horizontal baffle over the bottom rows of tubes was in bad condition, while one side wall had bulged away from the vertical baffle, allowing the flue gases to be short-circuited. These conditions were remedied, the drums were cleaned, all the tubes bored and a Cameron distributing valve was installed on the feed line to distribute the feed water into the three drums evenly; it had been previously noticed that the middle drum at times carried a higher water level than the others. This was evidenced by the fact that water was frequently blown from the safety valve of the middle drum when the water gage for the first drum showed only half a glass. This boiler then showed an efficiency of 75 per cent.

By reboring the tubes of the other boilers and by increasing the size of the combustion chamber, the efficiencies of the other boilers were raised slight amounts. It appears that the boiler plant can be operated at an over-all efficiency of 80 per cent by the use of instruments, and this means a saving of $8,000 a year in coal alone.

Two years ago, as has been stated, it was the custom to operate the two single-stage air compressors with low-pressure steam in order to utilize the steam from the bleeder turbine. Often, however, the feed water could not absorb all the exhaust heat discharged by the compressors, and considerable steam was lost through the atmospheric exhaust of the feed-water heater. The cost of air was excessive.

To overcome this, the policy of using high-pressure steam on the air compressors when the feed water became too hot was inaugurated; the air-distributing lines were explored for leaks which were eliminated wherever found, and the use of air in the departments was curtailed whenever possible. A saving of $7,495.58 from the old cost of $12,340.13 was made.

As the use of high-pressure steam on the air compressors is accompanied by a decrease in the efficiency of the bleeder turbine and a corresponding increase in the unit cost of electricity, the foregoing is not an actual over-all saving. To figure the exact saving is almost impossible, but we are convinced that this method of operation is the more economical. It is rare, at present, to exhaust steam to the atmosphere through the feed-water heater.

The steam rate of the generators was recorded on the various reports. In this way it was known at once when the bleeder machine began to decrease in efficiency. It was taken down and given a thorough overhauling with the result that the steam rate decreased 3 lb. per kw.-hr., a saving of approximately $2,583 per year in coal.

We have used our records advantageously from both operating and accounting viewpoints. We have bettered our combustion; we have checked the operation of each boiler, which has resulted in our discovering the inefficient boilers. Knowing this, we have repaired the boiler settings, repaired and renewed the baffles, reduced the sifting of coal into air chambers to a minimum, with the result that the over-all efficiency of the boiler plant has been raised from 72 to 80 per cent. We have cut the cost of the manufacture of air and increased the effi-

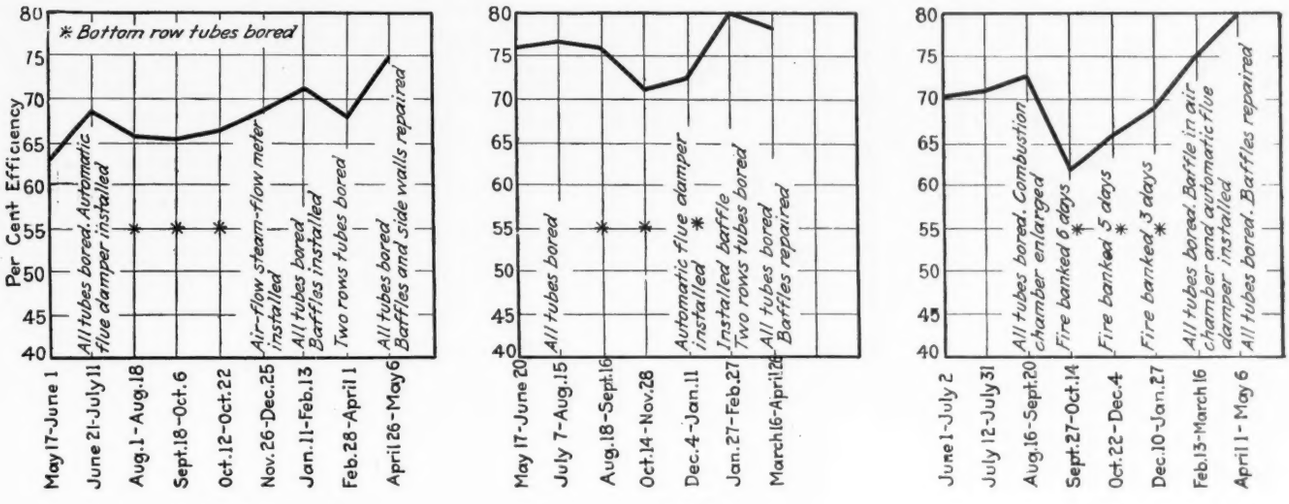


Fig. 3—Effect of maintenance on boiler efficiency

ciency of the air compressors and the turbine-generator.

Leaving out the saving of $7,496.58 which appears on the books in the Air Department, because of its not being an actual over-all saving on account of some increase in the cost of electricity, as stated, this station has made savings in the coal consumption as follows:

Boiler house	$8,000
Electric department	$2,600
Total	$10,600

The chart in Fig. 4 shows the metering system of the plant. It will be noticed that everything is metered except the feed water, the steam to the feed pumps and the boiler-house drips.

When No. 1 turbine is run, the meter from the No. 2 machine is changed over. The feed pumps take 800 lb. of steam per hour, which is checked now and then by operating them with steam from the header supplying steam to the air compressors, which is metered by the air-compressor meter. The boiler-house drips are checked now and then by weighing the water discharged. With such a complete system of metering, it can be seen that accurate knowledge is had at all times of the steam output of the boilers as well as of the steam consumption of the prime movers and of the various processes. A meter in error can be spotted instantly, for when one is in error, the various balances do not check. The electricity is metered as thoroughly as the steam, as are also the city and service waters.

The plant is considered as if it were a separate concern selling steam, electricity, air and water to the other factory departments at the cost of manufacture.

A power report is made out every day which shows: the reading of every meter, steam, electric and water; the efficiency of each boiler and the plant as a whole; the steam rate of the generator, average feed-water temperature, average day and night load of the generator, and in fact, any and all information obtained daily.

Once a week a heat balance is made and the cost of steam, electricity and air figured, and on the fifteenth day of the month bogey costs of power, light and heat to each department are calculated. These reports are sent to the department heads, superintendent and works manager.

Every month a report is made out which includes a heat balance of the boiler plant and the itemized distribution of costs of the steam, electric, air and water departments with amounts used and costs to each department.

Steam is sold on the B.t.u. basis, and any differences between the total steam generated and steam distributed is charged against the boilers. The exhaust steam not used to heat the feed water is charged to the air compressors. A minimum charge of 10 per cent of the steam input to the compressors is charged against the compressors; when the steam used by the feed water is less than 90 per cent of the input to the compressors, the balance is charged against the compressors.

The greater the amount of steam lost through the atmospheric exhaust of the feed-water heater, the greater will be the amount charged against the compressors.

The feedwater is pumped from the condenser of the turbine-generator by a centrifugal pump to a feed-water heater of the open type, where it is further heated by the exhaust from the feed pumps and air compressor. All boiler and engine room drips are also piped to the heater.

The water is drawn into the condenser by the vacuum obtaining there, where it absorbs from 30 to 45 B.t.u. per lb. This heat is charged against the boilers and credited to the electric department.

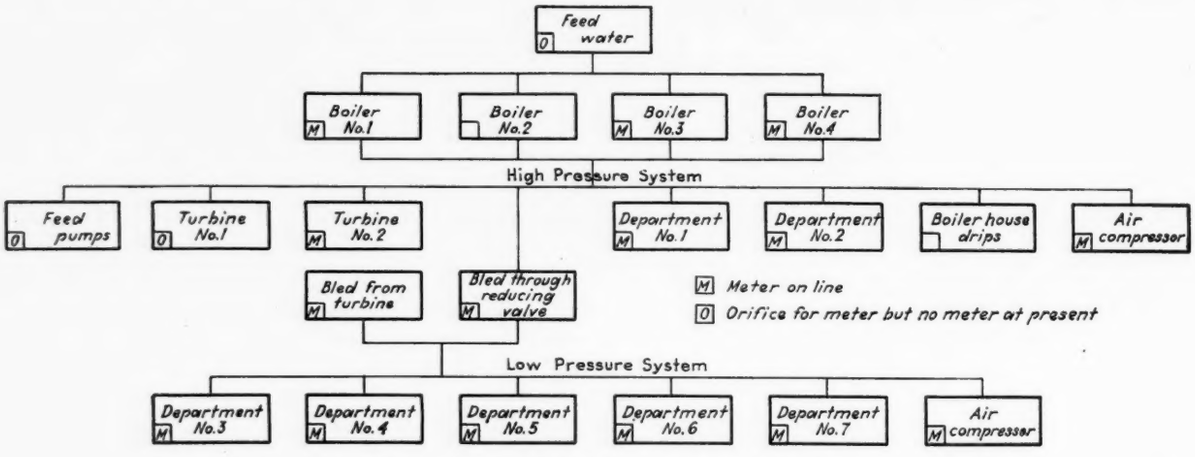


Fig. 4—Where meters are used in the plant

A Fast Job

Faced with the problem of increasing the steam capacity without dropping the load, the plant of the Atmospheric Nitrogen Corporation, Syracuse, N. Y., remodeled first one, and then the other, of its two 5,000-sq.ft. boilers in remarkably short time. New stokers were installed, which doubled the steaming capacity and saved the cost of a third boiler. The story will be told in an early issue.

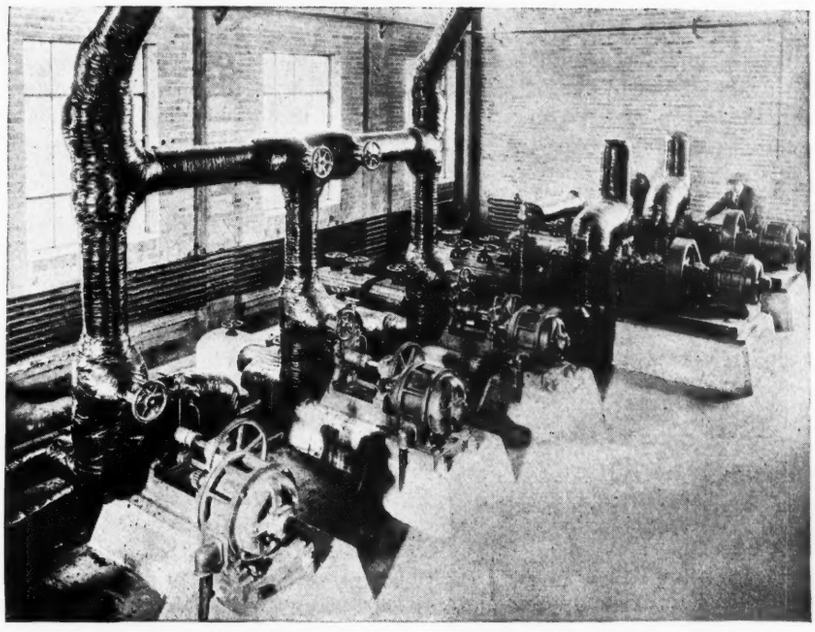


Fig. 1 — Insulation of the oil lines and pumps

Insulating Pipes and Tanks

In an Oil Refinery

BY H. L. KAUFFMAN
Engineer, Denver, Colo.

A LARGE amount of refrigeration is lost through the absence of proper insulation on the brine and other cold liquor lines in the oil refineries. As it costs money to compensate for this loss, the Producers & Refiners Corporation completely insulated all the lines in the Sharples dewaxing plant of its Parco, Wyoming, refinery.

Refrigeration plays an important part in the manufacture of lubricating oils, consequently the insulation of oil and brine lines and tanks against the warmth of the outer air is nesessary in all refineries making lubricating oils from paraffin or mixed-base crudes. This dewaxing plant was completed in December, 1924, by the J. G. White Engineering Corporation, and has been in operation since that time at such intervals as were necessary to keep on hand a stock of finished lubricating oils. The plant has a capacity of 333 barrels of finished stock per day and is different from all other Sharples plants, because the extremely high wax content of the crude oil used necessitates the passing of the diluted, chilled stock twice through the centrifuges in order to obtain a satisfactory cold test on the reduced oil. Twenty-one Sharples centrifuges and two Carbondale refrigerating machines of the atmospheric type, having a capacity of 100 tons each, are part of the equipment.

> An oil refinery, by its character, must have its equipment exposed to moisture. Insulation must be rightly chosen and properly applied if it is to last. The methods used at the Parco, Wyoming, refinery can be well adopted by other industries.

The lines carrying both the brine and chilled oil, at a temperature of —10 deg. F., that are insulated at this plant, are located both inside and outside the Sharples building.

In applying the insulation, all the pipe and fittings were cleaned and wiped dry. This was followed by the application of one layer of Johns-Manville sealing waterproof membrane, wrapped spirally. Outside of this were placed four layers of one-inch insulating hair felt, which was securely fastened in place with strong twine, all abutting and longitudinal joints being staggered. A one-ply thickness of sealing waterproof membrane in two-ply construction was then applied, followed by two coats of waterproof sealing compound, the first coat being allowed to set before applying the second. After wrapping this building insulation with two layers of waterproof paper, a canvas jacket was sewed on. The canvas was given two coats

of paint; different colors were used to indicate the type of line.

The method of insulating the lines outside the building and exposed to the weather was similar to that of insulating the inside lines, with the exception that instead of the two layers of waterproof paper and the canvas jacket, the lines were covered with a weather-protecting jacket consisting of a layer of two-ply Salamander roofing, with its white side exposed.

On both the inside and outside chilled oil and brine lines all fittings and flanges were covered with the same thickness of hair felt as were the pipes. A waterproof sealing cap was applied to inclose the ends of the pipe insulation at all fittings and flanges.

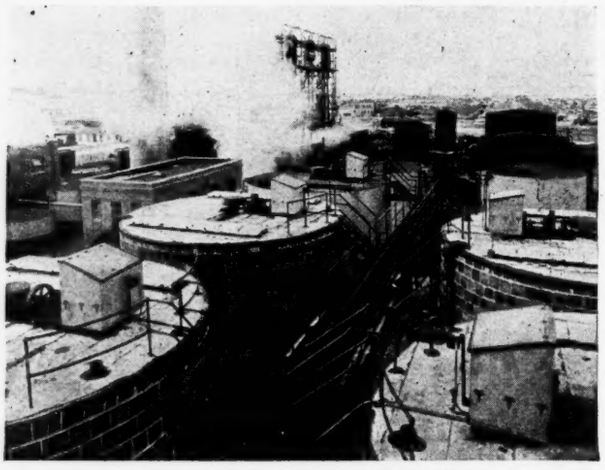


Fig. 2—The tanks after insulation

After being cleaned the sides and roof of the storage tanks were painted with a single coat of asphaltic paint before the application of four ¾-in. layers of insulation applied in hot asphalt. The side insulation is protected against the weather by five inches of hollow tile and the roof protection consists of a layer of two-ply asbestos-felt roofing and a layer of two-ply Salamander felt, all laid in hot asphaltic cement. The steel tank bottoms rest on Sil-O-Cel bricks which in turn are supported on a concrete slab.

Hair-felt insulation was applied to the liquid end of five 8x8½x12-in. Worthington duplex pumps, three 6x6x6-in. Kinney rotary pumps and one No. 2 Roots pump installed in the pumproom of the Sharples plant.

The sides and roofs only of the storage tanks were insulated. The surfaces, after being cleaned, were painted with a single coat of asphaltic paint before the application of four ¾-in. layers of tank insulation, applied in hot asphalt. The insulation was placed in vertical layers in continuous sheets, with broken joints, and was held in place by wire wrapped around the entire circumference of the tanks. The fourth, or outside, layer was held in place by 1½-in. mesh chicken wire. The wire was then given a mop coat of asphalt and the surface finished smooth.

Storage Tank Foundations

The steel-tank foundations rest on Sil-O-Cel bricks, these in turn resting on 8-in. concrete slab. The insulation at the bottom of the tank was made to extend over the brick, care being taken to be sure that the whole was made weatherproof and airtight. A weatherproofing protection of five inches of hollow tile was applied next. All flanges, manways and other projections were flushed and made weatherproof and airtight.

The method of insulating the roofs of these tanks was similar to that used on the sides, with the exception that in place of the weatherproofing protection of hollow tile inclosing the insulation on the tank sides, there was applied a layer of two-ply asbestos-felt roofing, followed by a second layer of two-ply Salamander felt. All roofing was laid in hot asphaltic cement. The roofing insulation was made to extend over the side insulation at this junction.

A 10x6x6-ft. steel brine tank containing a solution of calcium-chloride brine at approximately —10 deg. F., was located upon a concrete foundation on the roof of a building, where it was exposed to weather conditions. The sides and roof of this tank were insulated in a manner similar to that followed in insulating the other tanks, with the exception that after the chicken wire was fastened securely in place, the whole was given a smooth trowel cement finish. Over this was sewed a layer of 10-oz. duck; this was free from wrinkles or other irregularities and, consequently, presented a smooth surface finish. The duck was then painted with a coat of white waterproof paint.

The tank bottom was insulated with two three-inch layers of cork-board, having a density of 0.9 lb. per board foot, applied in hot asphalt. All the joints were broken and the insulation was made firm and smooth to give the tank a solid and level foundation. The tank was supported upon creosoted pine timbers, the cork-board resting between the wooden supports.

The heads and shells of the horizontal, shell-type anhydrous coolers were insulated in a manner similar to the insulation of the calcium-chloride steel brine tank, but five ¾-in. layers of tank insulation were applied.

The heads and shells of the horizontal shell-type brine coolers were insulated in a like manner, with the exception that six ¾-in. layers of "Tankinsul" were applied.

Four 2x8-ft. steel, vertical, shell-type exchangers and two 4.5x20-ft. steel, horizontal, shell-type generators were insulated according to the standard practice followed by the Carbondale Machine Company with these particular items of refrigerating equipment.

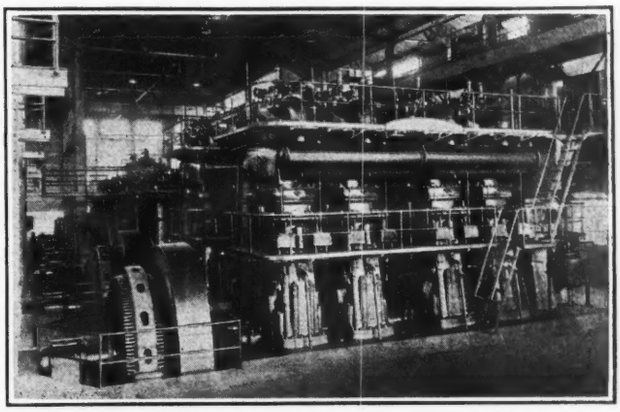
Fig. 3—Battery of dewaxing centrifuges

The reader is not to infer from this article that these methods of insulating brine and chilled-oil lines, tanks and refrigerating equipment described are the only satisfactory and efficient ones, but rather that the insulation and method of application as described is what one particular petroleum refiner has found to be entirely satisfactory and efficient. They are applicable in other industries where insulation must be protected from moisture.

How to Fit Piston Rings

In an Oil Engine

By O. W. Jennings



AN IMPORTANT feature of oil-engine operation is the maintenance of an effective seal at the pistons. For successful operation it is necessary to use rings that will work well, but not cause excessive wear to the cylinder and ring grooves, and they must be capable of withstanding a certain amount of abuse.

By reason of the pressure and temperature involved and the variation of these from end to end of the cylinder, we find that the latter does not wear an equal amount at the top and bottom. This is evidenced by the fact that the maximum amount of wear occurs at the top, or combustion end, of the cylinder.

If the wear were equal, the ring problem would be less, since renewals with oversize rings would re-establish a tight seal.

It is conceivable that a ring turned or ground to a diameter slightly less than the cylinder diameter would wear to a tight fit if the difference were not too great and if, in the meantime, the escape of gas were not so great as to wipe out the lubricant and augment the rate of cylinder wear to such an extent and at such a rate as to prevent any ring from wearing to a fit.

Since the taper is not true and the cylinder is barreled at the top, it is apparent that no ring can fit both at the top and bottom, nor can it bear evenly on such cylinder walls. The bevel of a ring worn to conform to the taper in the middle of the liner will not be such as to permit the ring to bear evenly while passing that part of the liner which is barreled. In the latter instance the ring must ride on but one corner. The tendency will be for the ring to twist in the ring groove and cause bevel wear.

It appears that cylinder wear is more affected by the size of the cylinder and the length of the stroke than by r.p.m., because of two very pronounced factors. The cylinder of a high-speed engine is rubbed more often, yet by virtue of its speed the length of stroke is limited. Obviously, an engine with a five-foot stroke could not run at 1,000 r.p.m., since in this case the piston travel would be at the terrific rate of 10,000 ft. per min. and the inertia forces would be prohibitive. In high-speed engines, however, we find a lesser amount of wear per unit of time in operation than in slow-speed ones, even though the cylinder is rubbed more often.

In fact, it is conceivable that high speed contributes to long life. Cylinder wear is frequently negligible midway in the stroke, where velocity of the piston is greatest. The top of the liner shows the greatest amount of wear, although at this point the rate of piston travel is slowest. The lower end, where the piston speed is obviously the same as at the other end of the liner, has practically no wear. Therefore we may assume that piston speed is of no consequence.

The length of stroke, however, is of more importance. Engines with short stroke have less cylinder wear than ones of long stroke. In all engines the question of pressure and temperature remains substantially the same. Therefore, we must determine what characteristic of operation may not be affected by speed and pressure as much as by length of stroke.

In all engines oil is applied at the lower end of the cylinder liner. It is carried upward by the piston and rings. A popular belief has been that the shape of the ring edge would cause oil to be pushed ahead of it. This is true to a certain extent, but no ring will ride over a film of oil of any great thickness, no matter how much the ring be beveled. It is conceivable that to bevel a ring and thus reduce the bearing surface on the cylinder wall, may cause a high initial pressure so that all benefit of the beveled edge will be overborne by the greater tension against the cylinder wall.

To approach a subject of less common knowledge, I will refer to what may be termed the wake of oil carried back of the ring. This wake forms as the wake behind the square stern of a canal barge, rolling and twisting up behind it. If the barge could be driven at express-train speed, the wake would break well clear of the stern, and at a certain point of speed it would rise in almost a jet, breaking high above the surface of surrounding water.

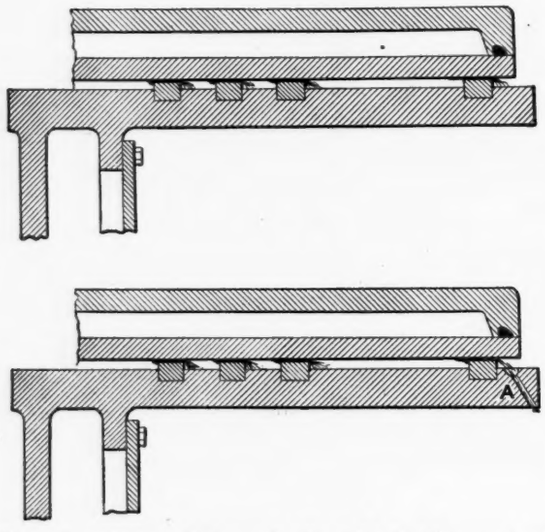
Some similar action occurs behind a ring traveling at high speed over an oily surface, as indicated in Fig. 1. In certain high-speed engines it has been utilized to throw the oil into a groove cut in the piston just below the ring, as in Fig. 2, and it was found that the greatest amount of oil, in place of being scraped into this groove, on the down stroke of the piston, was thrown into the groove as the result of its breaking away from the ring on the up stroke.

Under the circumstances it is apparent that the shape of the top of a ring will have less effect upon the quantity of oil carried away than that of the bottom, and if both sides of the ring are rounded, more oil will go up to cylinder wall than if either or both edges were sharp. This wake action tending to throw the oil off the cylinder will then have a greater effect on long-stroke engines than on short-stroke ones, since the piston travels

farther at high speed in the former than in the latter.

The mere fact of oil being removed from the cylinders, either through a scraping action or as the result of the wake mentioned, will have little effect except in the case of the lower ring on crosshead type engines. In trunk piston engines the oil would merely be thrown or scraped onto the piston again and find its way to the cylinder wall. It is common knowledge that to lubricate a trunk-type piston presents fewer problems than to lubricate one of shorter design.

In fitting oil-engine piston rings, we are as much concerned with the manner in which they will carry the



Figs. 1 and 2—Action of oil at high piston speeds

lubricant as the manner of effecting a seal. If a difference exists in the difficulties involved, the greater is in connection with making the oil perform as desired. If a ring bears firmly against the cylinder wall with sufficient pressure back of it to prevent it from collapsing, it will effect a good seal regardless of the shape of its edge, which, when rounded, will seal the gases just as well as when square. The ring cannot over-ride gaseous fluids, whereas it can ride on an oil film.

Assuming that all running conditions are correct, we still find it necessary to remove rings periodically. The mechanic may pull and haul in an attempt to lift them, and so spring the rings. This is bad practice. Another bad habit is to draw the ends apart to determine the tension. This will reveal the quality of the ring.

If, upon removing the rings, one or more are found with dark spots indicative of unequal bearing on the cylinder wall, the ring should be filed to a bevel at the point where it was bearing heavily. This will reduce the contact surface of the ring to the cylinder and cause more rapid wear, and cause the portion of the ring that was not touching to come in contact with the cylinder walls. When filing the ring in this way a portion of the original bearing surface should be left. The remaining narrow, original contact with the cylinder may be left on the upper or on the lower edge, in accordance with the manner in which the oil is intended to travel. In an engine that tends to "pump" oil the lower edge of the ring should be sharp. In one in which the cylinder is inclined to be dry the top edge should be sharp.

If the top or second from the top ring is filed in this way and the sharp edge is placed down, or away from the gas pressure, it is possible that the gas pressure between the cylinder and the ring will cause the latter to collapse. Aside from this the ring will seal the pressure just as well, no matter which way it is beveled.

If, for any reason, faulty rings are suspected, two tests should be made. The ring should be placed in the lower end of the cylinder and the distance between the ends measured to determine the amount of wear, remembering that the cylinder will be smallest at the bottom. Thereafter the ring should be tried in the top of the cylinder, where the amount of wear is greatest, and thickness gages should be tried between the ring and cylinder wall to determine whether it bears evenly. In badly worn cylinders it is not possible to fit a ring to bear equally at the top and bottom of the cylinder.

If it is found necessary to file to make the rings enter the ring groove, such filing should be on one side of the ring only. The filed side should be toward the pressure, because the lower side of the ring seals while in contact with the lower side of the ring groove.

It is sometimes necessary to provide a scraper ring in the lower ring groove. This ring should be beveled, and drains should be drilled from the groove to the inside of pistons of the trunk-piston type, as at *A* in Fig. 3. Only the scraper ring should carry a sharp lower edge and rounded upper edge. It will thus scrape the oil downward and will throw a certain amount of oil into the drain groove on the up stroke. If the groove is not drained, the oil will flow back onto the cylinder. Some pistons, as at *B* in Fig. 3, have several such grooves.

Obviously, no amount of fitting will rectify troubles

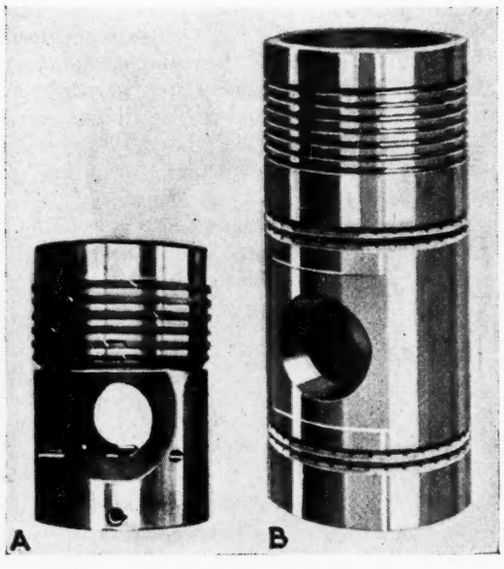


Fig. 3—Pistons with drained ring grooves

due to poor-quality rings. The depth of the ring groove may be measured with sufficient accuracy with a machinist's scale. The thickness of the ring groove may be determined by inserting a piece of broken ring in the groove and measuring the clearance with thickness gages, and adding that to the micrometer thickness of the piece of ring. Clearance in the groove is important. It should not be too great; 0.006 in. will generally be sufficient no matter what the size of engine, but as little as 0.003 in. is used on some small engines. All ring grooves wear, consequently the original clearance will not remain constant, and we seldom find an old engine in which this clearance at all resembles that originally provided.

SCHEDULING UNITS
in the Power Plant

BY C. D. ZIMMERMAN
Assistant Superintendent of Power
The Pennsylvania-Ohio Power & Light Company

THE most important work in a steam power plant from the viewpoint of economy or efficiency is the determination of such factors as the best systems of stoker and furnace operation, means of obtaining the best (not necessarily the highest) condenser vacuum, and the economical balance between station feed-water temperature, boiler-room efficiency and station water rate. The data obtained in this work are all that are needed to construct load distribution schedules, as they are sufficient for plotting input-output curves for each power unit with its best system of operation.

Savings possible by the use of correct operation schedules are largely indeterminate as the gain is due partly to better load division and partly to standardizing operation. That due to improved load division depends on the load curve, the character of operation and the similarity of the power units used and usually ranges from ½ to 2 per cent. The saving due to standardizing operation is likely to be greater. The cost of constructing power plant schedules is an inappreciable fraction of the saving. One way to plan such schedules is here described.

No general rule for load distribution can be given. The usually accepted rule that the largest units be loaded at their most efficient points has, in the writer's experience, always been found to be incorrect, and he believes that a better rule is to load the largest and most efficient units to their maximum capacity with due regard to maintenance and continuity of service. The spare capacity is carried by the smaller and less efficient units, and the amount of spare capacity is usually made equal to the capacity of the largest machine used.

Furnace maintenance is not considered in the following calculations on load schedules, because operation can be made such that its maintenance is more a function of the hours' use and the number of banks and outages than of the rating carried. As furnace temperature varies directly with rating and inversely with excess air, and as wall erosion depends on furnace temperature and the character of the coal used, a furnace temperature below that at which wall erosion occurs can be maintained for all ratings by making the excess air used increase with the rating in the proper amount for the installation considered. The excess air to be used for each rating depends on the kind of coal, kind of wall, ratio of furnace cooling surface to refractory surface and the amount of air preheat.

For the average installation this system of furnace operation results in an increase in the excess air used at high ratings and a decrease at low ratings so that the average excess air is increased. In general this means a decrease in efficiency, but for some stoker installations it may be slight owing to a compensating saving in the ashpit loss. This decrease is naturally less for a boiler with an economizer. For the installations investigated by the writer, this excess-air system of furnace operation results in a small decrease in efficiency but an appreciable financial saving.

In the average power plant a turbine schedule of loading can be followed with a high degree of accuracy. This is especially so where good condensing water is used. Where condensing water conditions are poor, the best loading distribution changes periodically as condensers become dirty and are cleaned. For such conditions it is best to use approximate schedules, which are changed as the conditions change.

A boiler schedule of loading is obviously much more difficult to follow accurately than a turbine schedule because boiler control is never entirely centralized. Also, conditions that affect the economical distribution of loading, such as coal used or quality of repairs, often change, and make a predetermined schedule not exactly true for each day. Yet some plan of loading must be followed. In order to realize the gain due to economical boiler loading and the gains due to the standardization of operation, a boiler schedule is recommended.

If complete data, such as water rate curves or boiler efficiency curves, are not at hand, an appreciable saving can be made by using an approximate schedule based on estimated data, such as manufacturer's guarantees, tests of similar units at other plants, determination of boiler losses by analyses of ash and excess air, etc.

In using loading schedules, operators should understand that they are a guide for economy and do not apply to emergency conditions.

When constructing a schedule, two points should be emphasized—first, the basic data for the schedule should apply to actual conditions, and second, all the factors which have an effect on economy and which vary with

the output of any one unit should be considered in determining the input-output curve for that unit. In the following cases, with the exceptions noted, the turbines and boilers are considered as connected to one main steam header.

Turbine Schedules

Case I. No steam bleeding or resuperheating, regular input-output curves.

The data necessary for each unit are the water-rate curve for constant condenser vacuum, vacuum correction curves, condensate temperature as a function of load, and condenser vacuum as a function of load. The water rate and vacuum correction curves are obtained from test data, and the condensate temperature and condenser vacuum for different loads are obtained from performance data for the period in question. Examples of these data are shown in Figs. 1, 2, 3 and 4.

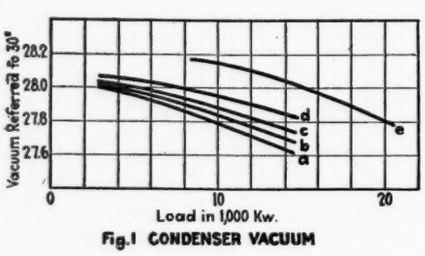


Fig.1 CONDENSER VACUUM

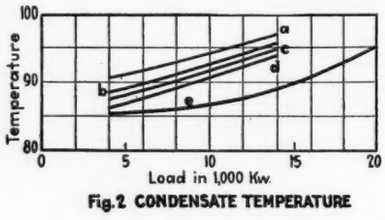


Fig.2 CONDENSATE TEMPERATURE

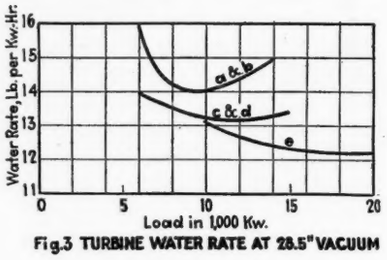


Fig.3 TURBINE WATER RATE AT 28.5" VACUUM

As these data change with changes in the temperature of the circulating water, a loading schedule should be determined for two or more periods per year. The input-output curves, Fig. 5, are then calculated for each machine, using the vacuum, water rate and condensate temperature for the corresponding load.

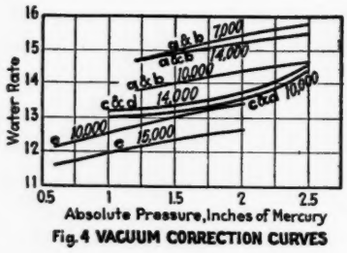


Fig.4 VACUUM CORRECTION CURVES

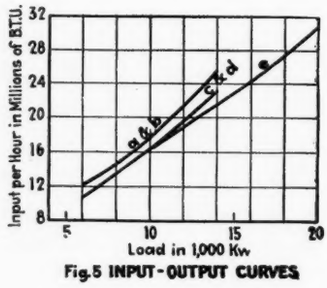


Fig.5 INPUT-OUTPUT CURVES

The slopes of these input-output curves are then plotted as shown in Fig. 6. Convenient units are increments of input per unit increment of output. The loading is then chosen from these curves by taking the load for each turbine, from constant slope lines (horizontal) intersecting each curve. A load schedule derived in this manner is shown in Table I.

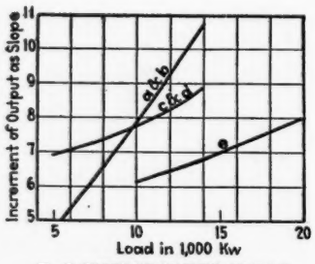


Fig.6 SLOPE OF CURVES OF FIG.5

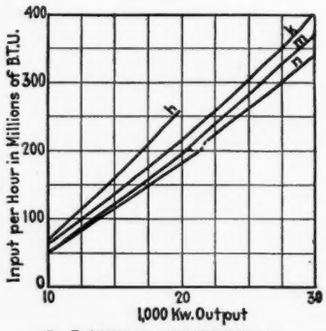


Fig.7 REGULAR AND IRREGULAR INPUT-OUTPUT CURVES

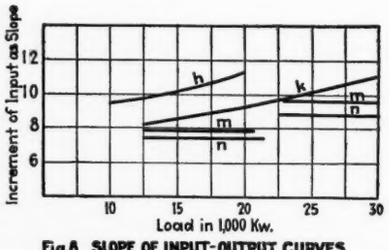


Fig.8 SLOPE OF INPUT-OUTPUT CURVES OF FIG.7

The slope method as applied to boiler loading was discussed in a paper entitled "Boiler Plant Economics," by N. E. Funk and F. C. Ralston, and is published in the 1923 Transactions of the A.S.M.E.

The application of this schedule to the loading for a complete day depends on the shape of the load curve. For the average city load machines should be put on in the order of their ranking in efficiency, and taken off in reverse order.

Case II. No steam bleeding or resuperheating, irregular input-output curves.

For the average installation consisting of a number of machines having irregular input-output curves the foregoing method cannot be used. This can be seen by referring to Figs. 7 and 8, which show the input-output curves and corresponding slope curves for a group of four machines of which two have irregular input-output and slope curves. The straight cut-and-try method is impracticable for groups of three or more machines owing to the number of combinations necessary to be tried.

The following method is simple, exact and comparatively short. The economical loading for any two machines is first determined throughout their capacity range by the cut-and-try method, one step of which is illustrated in Table II. The corresponding input and outputs of these two machines are then combined at convenient load increments, and these two machines are considered as one machine and the same process repeated with the third unit. This method is repeated until all the units have been used and a complete schedule of economical loading is derived.

As the load division for any total load derived in this

manner is the most economical one for the number of machines used, it also gives the economical loading for a smaller number of machines. For example, in Table III, which shows a portion of a schedule for seven machines, if machines No. 3 and No. 5 become unavailable, the schedule becomes as shown in Table IV.

The schedule is used to determine the operation for

TABLE I—DIVISION OF LOAD BY SLOPE METHOD AMONG TURBO GENERATORS HAVING REGULAR INPUT-OUTPUT CURVES

Total Load (1,000 kw.)	a	b	c	d	e	Total Load (1 000 kw.)	a	b	c	d	e
24	7	7	..	..	10	56	10	10	9	9	18
27	8	8	..	..	11	59	10	10	10	10	19
28	8	8	..	..	12	62	10	10	11	11	20
29	8	8	..	..	13	66	11	11	12	12	20
30	8	8	..	..	14	68	11	11	13	13	20
45	9	9	6	6	15	72	12	12	14	14	20
48	9	9	7	7	16	74	13	13	14	14	20
51	9	9	8	8	17	76	14	14	14	14	20

the average day, and the turbines used depend, as stated previously, on the shape of the load curve and the spare capacity desired. In general, peaks of short duration are carried by putting on machines requiring the least amount of starting steam, and for steady loads machines are put on in the order of their efficiency ranking and taken off in the reverse order.

Case III. Steam bleeding. No resuperheating.

Before the turbine schedule is constructed, the economical feed-water temperature for the plant as a whole should first be determined. The factors to be considered are discussed in a paper entitled "Steam Bleeding and Turbine Performance," by the writer, and published in the 1925 Transactions, A.S.M.E. The input-output curves can then be constructed and the succeeding proce-

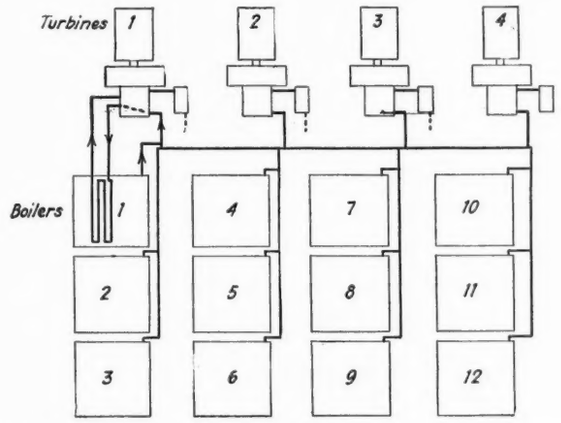


Fig. 9—Representing steam bleeding and resuperheating

dure is as previously outlined. The input to each machine is the total steam times the difference between the heat per pound in the initial steam and the heat in the total condensate per pound of initial steam after leaving the last bleeder heater.

TABLE II—ILLUSTRATION OF CUT-AND-TRY METHOD TO DETERMINE THE LOAD DIVISION FOR TWO TURBINES FOR A TOTAL LOAD OF 48,000 KW.

Unit 1		Unit 2		
Output (1,000 Kw.)	Input (Million B.t.u.)	Output (1,000 Kw.)	Input (Million B.t.u.)	Total Input (Million B.t.u.)
18	243.5	30	404	647.5
19	254	29	391	645.0
20	264.5	28	378	642.5
21	275	27	365	640.0
22	290	26	352	642.0
23	302.5	25	339	641.5
24	315	24	326	641.0
25	327.5	23	313	640.5
26	340	22	300	640.0
27	352.5	21	287	639.5
28	365	20	275	640.0
29	377.5	19	263	640.5
30	390	18	251	641.0

The economical loading is therefore 27,000 kw. on unit No. 1 and 21,000 kw. on unit No. 2.

Case IV. Steam bleeding and resuperheating.

In general, turbines using resuperheat and high-pressure turbines should be loaded to their maximum and spare capacity carried by other machines, but in each

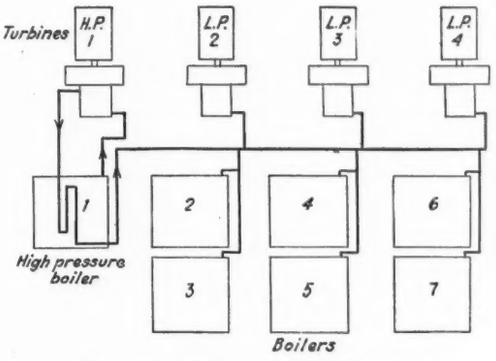


Fig. 10—Layout including high pressure turbine

case this system should be checked by actual calculations. Fig. 9 shows diagrammatically the cycle considered for this case.

The output of the reheat boiler depends on the steam used by the reheat turbine. For a given total load an

TABLE III—DISTRIBUTION OF LOAD AMONG SEVEN UNITS HAVING IRREGULAR INPUT-OUTPUT CURVES

Total Load (1,000 Kw.)	Unit	1	2	3	4	5	6	7
115	...	21	21	12	20	21	10	10
120	...	21	21	17	20	21	10	10
125	...	21	21	21	20	21	11	10
130	...	21	21	21	20	21	16	10
135	...	21	21	21	20	21	19	12
140	...	21	21	21	20	21	19	17
145	...	26	21	21	20	21	19	17
150	...	30	22	21	20	21	19	17
155	...	30	27	21	20	21	19	17
160	...	30	30	21	20	21	19	19
165	...	30	30	21	25	21	19	19
170	...	30	30	23	28	21	19	19
175	...	30	30	28	28	21	19	19
180	...	30	30	28	28	26	19	19
185	...	30	30	28	28	28	19	22
190	...	30	30	28	28	28	27	19
195	...	30	30	28	28	28	28	23
200	...	30	30	28	28	28	28	28

increase in the output of the reheat turbine causes an increase in the output of the reheat boiler and a decrease in the output of the other turbines and boilers. Therefore, a turbine schedule should not be constructed without considering boiler loading.

A turbine schedule for the machines without reheat is first constructed as previously outlined. A boiler schedule for the boilers without reheat is then constructed as outlined later. The complete schedule is then

TABLE IV—UNITS NO. 3 AND NO. 5 OUT OF SERVICE, FIVE UNITS CARRYING THE LOAD

Total Load (1,000 Kw.)	Unit	1	2	3	4	5	6	7
115	...	30	29	Out of Service	20	Out of Service	19	17
120	...	30	30		22		19	19
125	...	30	30		27		19	19
130	...	30	30		28		19	23
135	...	30	30		28		28	19
140	...	30	30		28		28	24
144	...	30	30		28		28	28

determined by considering the turbines and boilers without reheat as one unit and the turbine and boiler with reheat as the other unit, with part of the input being furnished by the boilers without reheat. The co-ordinates of the input-output curves for each of these power units are the heat in the coal fed to the boilers and the output in net kilowatt-hours. The schedule determined in this way is only approximately correct, as it is impossible to determine the exact boiler loading without know-

ing the load division for the turbines. A second determination of the input-output curves, based on the loading shown by the first calculation results in a loading schedule that will be very accurate.

Case V. High-pressure turbine.

Fig. 10 shows diagrammatically the cycle considered. The best economy for this cycle has been shown to be obtained by loading the high-pressure turbine to its

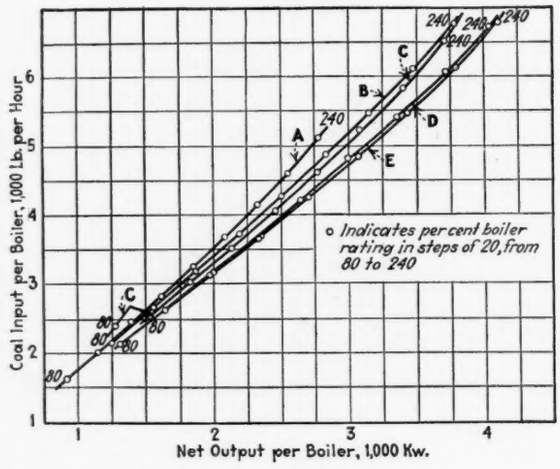


Fig. 11—Input-output curves

capacity and carrying all changes in loading by the other machines. This is especially the case if the high-pressure boiler is designed to give a high efficiency at the maximum load.

The calculation of a schedule for this cycle is similar to that shown for Case IV. A turbine and boiler schedule is first constructed for the low-pressure machines and these data are then used to construct an input-output curve for these machines considered as one unit.

TABLE V—UNITS 6 AND 7 OUT OF SERVICE

Total Load	Unit	1	2	3	4	5	6	7
115	...	30	23	21	20	21		
120	...	30	28	21	20	21		
125	...	30	30	21	23	21		
130	...	30	30	21	28	21		
135	...	30	30	26	28	21		
140	...	30	30	28	28	24	Out of Service	Out of Service
144	...	30	30	28	28	28		

A similar curve is then constructed for the high-pressure boiler and turbine.

Boiler Schedules

The method of using the slopes of the input-output curves for each type of boiler is discussed, as previously mentioned, in a paper by N. E. Funk and F. C. Ralston, published in the 1923 Transactions. In the following example there is illustrated a different method from that used by Messrs. Funk and Ralston of correcting for variations of superheat and auxiliary power.

Table VI is first constructed in the following manner for each type of boiler unit: Columns 3 and 4 are determined from operating data; column 5 is calculated from columns 3 and 4; column 6 is the operating efficiency; column 7 is calculated from columns 2, 5 and 6 and the B.t.u. per pound of coal; column 8 is the station water rate corrected to the superheat shown in column 4; column 9 is column 2 divided by column 8;

TABLE VII—BOILER LOAD SCHEDULE

Boiler Ratings in Per Cent					Boiler Ratings in Per Cent				
A	B	C	D	E	A	B	C	D	E
...	...	...	80	80	110	130	150	170	170
...	...	...	90	90	120	140	160	180	180
...	...	...	100	100	130	150	170	190	190
...	...	100	110	110	140	160	180	200	200
...	80	110	120	120	150	180	180	210	210
...	90	120	130	130	170	190	190	220	220
70	100	130	140	140	180	200	200	230	230
80	110	140	150	150	200	220	210	240	240
90	120	140	160	160					

column 10 is the auxiliary power chargeable to the boilers; column 11 is column 9 minus column 10; column 7 is then the input and column 11 the net output. Input-output curves are then constructed from data derived in this manner for each type of boiler unit. Examples of such curves are shown in Fig. 11, and the corresponding slope curves in Fig. 12. Table VII shows the load schedule for this example and is determined by drawing constant slope lines on Fig. 12.

Since the load division depends only on the characteristics as shown by the slope of the input-output curve

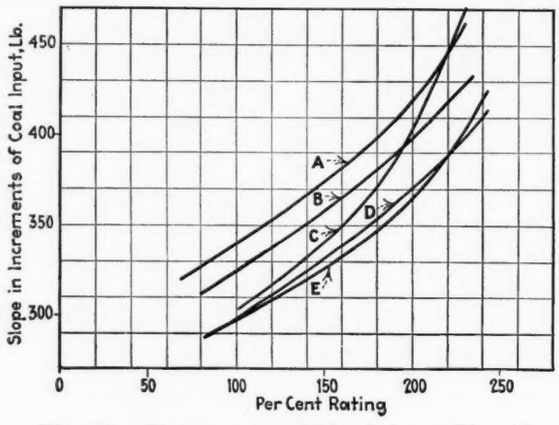


Fig. 12—Slope curves derived from Fig. 11

of each type of boiler considered, this division is independent of the number of each type used.

The minimum number of boilers to use is determined from the spare capacity desired. To determine if a larger number of boilers results in better economy, a few cut-and-try calculations are made to determine the total input for an average day with different numbers of boilers used. It is believed that as a general rule boilers should be carried to the lowest practicable point before banking.

TABLE VI—COMPUTATION FOR BOILER INPUT-OUTPUT CURVE

1	2	3	4	5	6	7	8	9	10	11
Per Cent Rating	Lb. Steam per Boiler Hr.	Feed Temp. To Econ.	Deg. Suphtr.	B.t.u. per Lb. Added by Boil.+ Sup.+ Econ.	Per Cent Eff'y	Lb. Coal per Boiler Hr.	Water Rate	Gross Kw.	Kw. to Auxil.	Net Kw.
100	96,103	180	209	1170	90.7	10,331	12.14	7,916	153	7,763
120	114,678	...	226	1179	91.0	12,381	11.93	9,613	192	9,421
140	133,666	...	238	1184	91.0	14,493	11.78	11,347	223	11,124
160	152,336	...	248	1190	90.7	16,655	11.65	13,076	256	12,820
180	171,060	...	258	1195	90.4	18,844	11.53	14,836	293	14,543
200	189,890	...	265	1198	90.0	21,064	11.44	16,599	332	16,267
220	209,073	...	270	1200	89.6	23,334	11.38	18,372	379	17,993
240	228,291	...	273	1201	89.0	25,672	11.34	20,131	435	19,696
260	247,315	...	275	1203	88.3	28,078	11.31	21,867	499	21,368
280	266,340	...	277	1204	87.3	30,610	11.29	23,591	565	23,026
300	285,629	...	278	1204	86.0	33,323	11.28	25,322	638	24,684

TAP-CHANGING EQUIPMENT

Controls Transformer Voltage

By Arthur Palme
Transformer Engineer, General Electric Company

Modern transformers may be had with load-ratio control that will give a voltage adjustment comparable with a generator. This control is applicable for the regulation of any bank of transformers down to individual transformers on industrial loads.

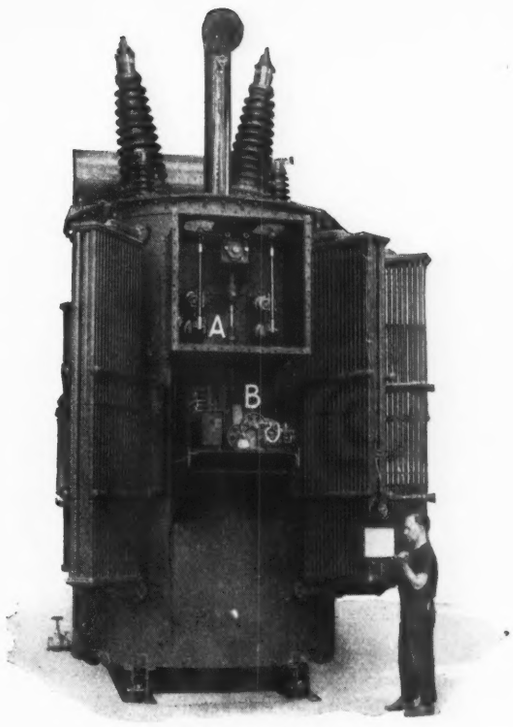


Fig. 2—Load-ratio-control equipment on side of transformer at A *and* B

NOT until about five years ago was the necessity of variable-ratio tranformers seriously felt. Long before then it was general practice to equip transformers with a number of taps on either the high-voltage or the low-voltage winding, or both, and to connect these voltage tap leads to a suitably designed multi-point switch (ratio adjuster). This provided a convenient way of changing the ratio. But the transformer had to be killed for the actual changing process, which meant a temporary shutdown of the line. This problem engaged the attention of engineers for many years. They had suggested and used various methods of changing the voltage taps on a transformer without interrupting the load.

A successful method used in American transformer practice is to equip the transformer with two independent windings, each winding with the necessary number of voltage taps connected to a ratio adjuster, and the two windings normally in parallel, equally sharing the load, both operating on the same tap. If a change of taps is contemplated, externally located circuit-breaking devices stop the flow of current in one of the parallel sections, making it possible to adjust the ratio in that section.

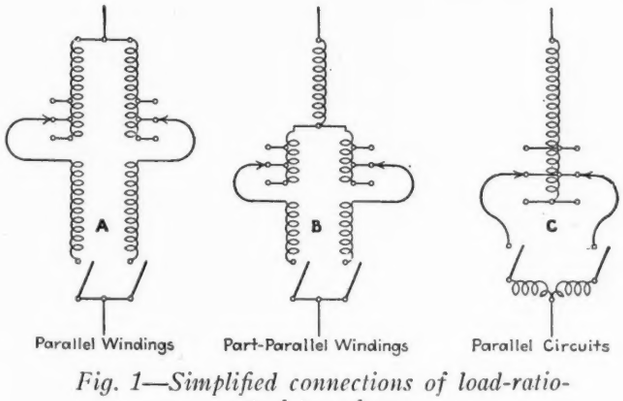


Fig. 1—Simplified connections of load-ratio-control transformers

While changing in one section, the load is temporarily carried by the other. A motor-operated mechanism accomplishes the full operating cycle in a few seconds.

This basic principle is applicable to practically all installations, but as the art progressed and after the designers had faced and investigated a great variety of conditions, they often found it more advantageous to modify this basic principle. They may, for example, restrict the parallel parts to only a certain section of the main winding and leave the rest common to both. Then, again, the designers may even go so far as to provide only one common winding, with its taps carried to two adjusters and the two external breakers. Choice of any one particular arrangement of the windings has no effect upon the function of the transformer. Fig. 1 shows in a schematic way the three main methods of ratio adjusting for a single-phase transformer.

During the first few years, when these equipments went through a more or less developmental stage, standard-type oil circuit breakers were used to accomplish the opening and closing of the parallel windings or circuits. The electrical duty imposed upon these breakers by their application to the opening of parallel circuits was quite different, however, from the duty for which standard-type oil circuit breakers are designed. While it was desirable to have the current carrying parts well insulated between phases and from phases to ground, the high rupturing capacity of the circuit breaker, which corresponds to this insulation, was sometimes considerably greater than required. When this was so, a well insulated circuit-breaking device with a moderate rupturing capacity would suffice. A new type of oil-immersed, single-break, high-voltage contactor was developed for this purpose, with characteristics exactly as required for this application.

Whichever is used, the operation of the external circuit-breaking devices must be synchronized or positively interlocked with the operation of the internal ratio adjust-

ers, which makes mechanical drive desirable. This can be readily accomplished by a suitably shaped cam.

Manufacturing and operating experience with tap-changing devices, gathered during the five years since its conception and involving approximately 2,000,000 kva. in transformer output by one firm, has culminated in a modern load-ratio-control transformer, a name given a transformer with ratio changeable under load, consisting of the following essential parts:

1. Transformer proper, with voltage taps and current-limiting reactive winding.
2. Two sets of tap switches or ratio adjusters, one set for each phase.
3. Mechanical gearing to reset adjusters, one set at a time.
4. External cam-operated circuit-breaking devices to open branch circuits.
5. Motor drive.

The core and windings of these machines do not differ from straight transformers with voltage taps. The same care in balancing tap sections against the main winding to avoid undue mechanical stresses is exercised on these, as on any other transformers. A current-limiting reactance must be used to restrict the shorting of one tap section during the switching cycle. The designer will often find it possible to place this reactance winding on the main core of the transformer, in which case the customary appearance of the winding is not changed. At other times he may find it more economical to build a separate reactor with its own core. Then this relatively small unit is attached to the main transformer and is placed in the common oil tank.

There is another problem which may affect the transformer appreciably, which is met when the application requires the switching equipment for a non-grounded circuit of high voltage. In such case the cost of straight load ratio-control equipment would be too high. To avoid this, a double transformation is recommended, with the switching apparatus in an isolated circuit of a potential convenient to handle. The reduced over-all efficiency due to the double-step transformation is usually compensated for by the smaller capital tied up in the apparatus. If this method is resorted to, a twin transformer will be required, with two iron cores and two sets of windings; all the switching equipment is then placed in the circuit formed between the secondary of the first and the primary of the second transformer, completely isolated from both the incoming and outgoing lines. The two transformer units are usually mechanically combined one above the other or side by side in a common oil tank.

Ratio Adjusters

Wherever load-ratio control of a transformer is needed, a change of taps will frequently be required. Experience indicates that seven changes per day constitute a good average. The tap switch actually accomplishing this change-over will, therefore, be called upon to make approximately 2,500 operations per year. Only a very sturdy construction will answer this purpose. Such multipoint switches have been developed for six, ten, and twelve points, and have passed the most severe electrical and mechanical tests, showing no noticeable weakening after several hundred thousand operations and carrying current up to 25 times rated capacity.

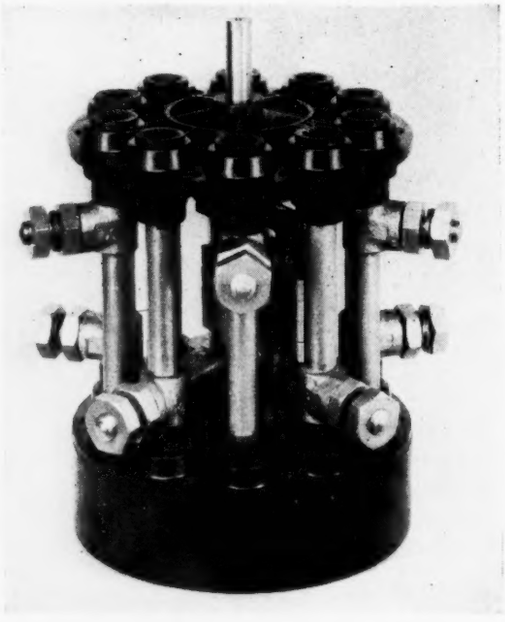


Fig. 3—Ten-point ratio-adjuster switch that permits nine connections to be made from one common pole

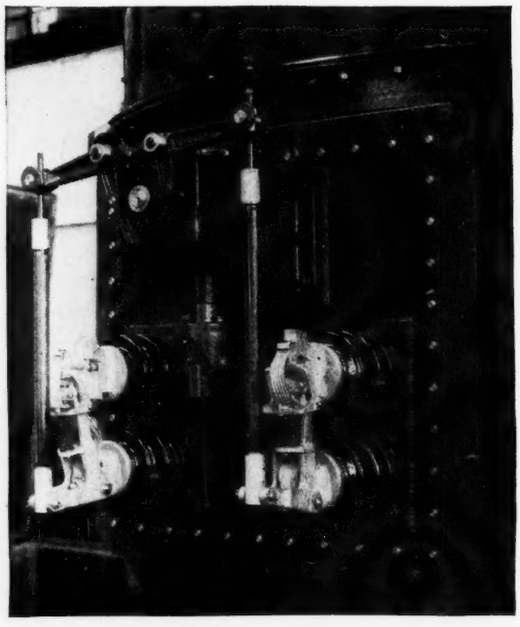


Fig. 4 — Cam-operated oil-immersed contactor for single-phase load-ratio-control equipment mounted on side of transformer, as at A, Fig. 2

It should be mentioned that these ratio adjusters are designed only for carrying current, not for interrupting it. The latest knowledge resulting from extended research work on electric contacts was applied to these ratio adjusters. The contact is not made by laminated copper leaves arranged in brush-fashion, but by a few strong and solid copper fingers, under the heavy pressure of helical springs. The design of the adjuster is of such mechanical nature that the combined pressure on all the contact fingers together can be obtained with surprisingly small effort on the driving shaft.

An example of such a ratio adjuster is shown in Fig. 3. This type is a ten-point adjuster, permitting nine connections to be made from one common pole. The top and bottom heads of these adjusters are molded from a Bakelite compound of comparatively thin section, but well reinforced by numerous ribs. Additional dielectric strength is provided by a short Herkolite sleeve around each of the ten copper rods where they are held in the compound heads.

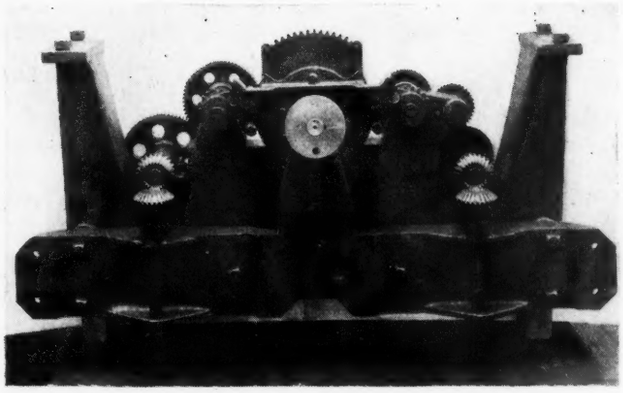


Fig. 5—Intermittent gear for operating the load ratio adjuster

The tap-changing process is essentially a two-cycle operation; that is, the two circuits in the transformer are changed one at a time. Each branch has its own ratio adjuster, and provision must, therefore, be made to have these two adjusters geared together in such a manner that from a uniformly turning driving shaft, one of these adjusters is turned at a time. A simple intermittent gear has been designed for this purpose, shown in Fig. 5. The gear sector is in its neutral position (upward), and when its shaft makes one complete revolution, it will mesh first with the small pinion on one side, and then with that on the other side, giving each one turn. A train of spur gears transmits the motion on either side to the center lines of the two ratio adjusters.

This intermittent gear is mounted rigidly to the upper core structure of the transformer, and its horizontal driving shaft extends through an oiltight stuffing box in the side of the transformer tank. A universal coupling in this shaft compensates for minor misalignments.

The sturdy construction of both the adjuster and the gear, their perfect lubrication by being always oil-immersed, and their relatively infrequent operation (on an average of seven times a day and two seconds every time) make it unnecessary to service these parts after they leave the factory.

External Circuit-Breaking Devices

To stop the flow of current in one or the other of the two normally parallel windings over the two ratio adjusters, two external circuit-breaking devices are required. They serve to divert the flow of power temporarily from two paths into one path. This means that their rupturing capacity should be approximately one-half the line current and slightly more than the voltage of one tap. They are oil-immersed to obtain a maximum of electrical strength with a minimum of size. The standard-type oil circuit breaker, used at first, was soon recognized as being merely the application of an existing apparatus to a new use for which it was not fully adapted. A more suitable current rupturing device was developed with characteristics in accordance with the special requirements of this new field of application.

Low cost and small space requirements are the salient features of this new type of interrupting devices, which are termed oil-immersed contactors. They have large surfaces, self-aligning, silver-faced current-carrying contacts, and extra-heavy, renewable arcing tips. Since the arcing tips close before and open after the silver contacts, all arcing is confined to them. A certain wear is to be expected on the contacts of this device, but the tips contain a sufficient amount of arcing metal to last under full-load conditions for at least 7,500 operations, representing about two years of service.

The oil in which these contacts operate will become gradually carbonized. Experience indicates that this carbonization has no detrimental effect on the switching apparatus and that an exchange of the oil will, in general, not be required until it is time to renew the arcing contacts. It should be remembered, however, that the carbonization of the oil is restricted to the oil in the contactor tank and that the contactor tank has no communication with the main transformer tank.

Since it is necessary to have the operation of the external circuit-breaking devices in exact time sequence with the operation of the internal ratio adjusters, the same shaft which drives the adjusters also drives the contactors. A specially shaped cam, suited to the required closing and opening speed of the particular contactor type used, is keyed to the common driveshaft, and bell cranks with roller arms follow the contours of this cam. To insure positive opening the cam is of the so-called closed type.

Motor Drive

The combination of ratio adjusters and contactors described in the foregoing is motor driven and remotely controlled by a push-button on the station switchboard. A 1½-hp. motor with suitable gear reduction, magnetic brake, limit switch, controller, etc., is assembled to form a compact driving unit, Fig. 6, which is mounted directly under the contactor tank in a weatherproof casing.

One complete tap-changing cycle consumes but two secseconds. To indicate the tap position to the operator in the station, a small casing is mounted on the switchboard, containing as many low-voltage lamps as the transformer has taps. Each lamp has a numbered glass lens in front of it. A multipoint dial switch, attached to a suitable shaft in the driving mechanism, changes the current to these position lamps on the switchboard as the taps on the transformer are changed.

Should the power supply to the motor fail before the mechanism has finished a once-started cycle—a very unlikely occurrence—the operator in the station receives an optical signal, and a few seconds later a gong is

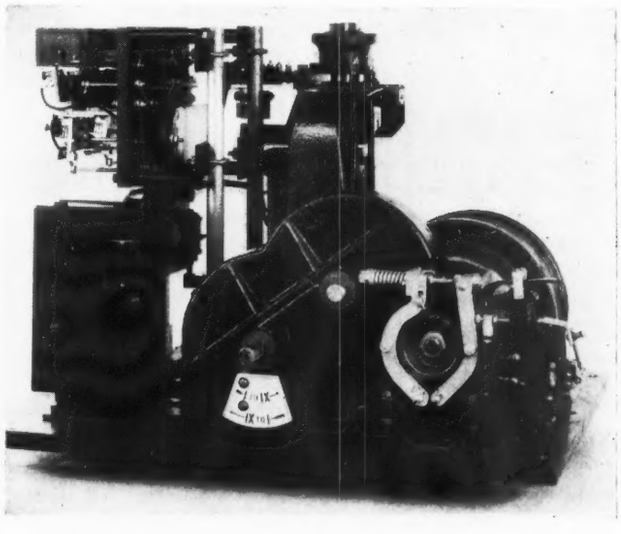


Fig. 6—Complete motor-driven ratio-adjuster equipment, before mounting on transformer, as at B, *Fig. 2*

sounded to notify him that the transformer stands on an inoperative position. By four turns of a hand crank the operator may change taps under load in this emergency. To keep the operator informed about the number of tap changes made in the course of time, an integrating counter is included in the driving mechanism.

A typical example of a complete load-ratio-control transformer is shown in Fig. 2. These equipments are standardized for either single-phase or three-phase transformers, the single-phase for circuits up to 73,000 volts, the three-phase for circuits up to 37,000 volts, and either type up to 800 amperes.

The application of load-ratio control is by no means restricted to tie-in transformers. The same equipment can be used for the regulation of any bank of trans formers or any block of power, down to individual transformers for an industrial load, such as, for example, furnace transformers. The problem of voltage regulation, which years ago was of paramount importance in direct-current systems and was solved in a satisfactory way, became in late years again prominent for alternating-current systems. The load-ratio-control transformer, with its wide variety of possible applications, represents the modern solution to this problem.

Applications for Squirrel-Cage Motors Extended

By E. F. Rogers

IN THE last few years squirrel-cage motors have been designed and put on the market with characteristics that are considerably different from those of the usual type. There were many instances where compressors, conveyors or elevators could use squirrel-cage motors if it were not for the fact that they, as ordinarily designed, could exert only about 125 per cent full-load torque when starting on full voltage. Since most power companies insisted that squirrel-cage motors above a certain size be started on reduced voltage, they were not suited to loads requiring even medium starting torques. Slip-ring motors, because they can exert a maximum torque at zero speed if the correct amount of resistance is connected across their rings, were used extensively on load requiring high-starting torques. If it were desired to take advantage of the sturdiness, low upkeep and simplicity of the squirrel-cage motor, it was necessary to use one that was considerably over-size, so that it would have sufficient torque to start the load. This naturally increased the original investment.

Squirrel-cage motors are now available, which have high-resistance rotor windings. This type has advantages over the ordinary type in that it has a high torque at starting and its inrush current is low compared to the low-resistance rotor type. The first advantage made it possible to use these motors on loads requiring high starting torques, without using an over-size rating. The second advantage allowed starting on full voltage without a compensator or resistance starter.

These advantages were gained at a sacrifice in other characteristics of the motor. The efficiency is about 5 or 6 per cent lower than that of the ordinary type. The speed regulation is not as good as for the low-resistance type. That is, the full-load speed of a motor having 900 r.p.m. synchronous speed might be as low as 800 r.p.m. where an ordinary squirrel-cage motor would have a speed at full load of around 875 r.p.m.

It was found best to use the high-resistance rotor motors for driving machines like elevators or hoists which have an intermittent load cycle. Since, these machines made numerous starts and stops in the course of a day's run, the high starting torque and the low starting current was a decided advantage. On the other hand, the lower efficiency and higher heating of the rotor was not of much consequence, because motors on these loads do not operate for a very large proportion of the time. The higher losses due to power efficiency did not exist during the rest periods and these gave the motor a chance to cool off.

Conveyor and Compressor Loads

In order to take care of the other type of load as exemplified by the conveyor and compressor, the double-squirrel-cage motor came into existence. This motor has a high-resistance rotor winding to give the requisite high torque and low inrush current at starting. It also has a low-resistance winding, as used in the ordinary type of squirrel-cage motor, for running. The high-resistance winding is near the outside of the rotor and automatically comes into use when needed at starting, and after doing its duty in getting the machine running, it steps out of the picture and lets the low-resistance winding with its higher efficiency carry the load when the motor gets up to full speed.

Besides these two there is a third new type of squirrel-cage motor, which has a rotor winding similar to the usual type but embedded farther in the rotor core. Motors with these rotors give low starting current and low starting torque. These machines are suitable for starting and driving centrifugal pumps and fans which do not require a high starting torque. The low starting torque and current characteristics of this type make it suitable for use without a starter. It will draw no more current from the line without a compensator or resistor starter than the ordinary type of squirrel-cage motor will, when using a compensator. It will also exert about the same starting torque on full-line voltage as the ordinary squirrel-cage motor does when using a compensator. The efficiency of the two types of motor will be approximately the same.

As a result of having these comparatively new types of squirrel-cage motors, the power company, as well as the industrial power user, is benefited. The power company is benefited because squirrel-cage motors are available that have much less inrush current than formerly. The power user in some cases can save the difference in cost between a slip-ring and a squirrel-cage motor, and in other cases he is saved the cost of a reduced-voltage starting device.

There is evidence that many engineers still consider squirrel-cage motors as being all alike, but it would benefit both power seller and power user to consider carefully the load to be driven and make sure that the proper type of motor is selected. Of course, there are many loads which can best be served by a slip-ring motor, such as a crane hoist, but on the other hand some of the newer types of squirrel-cage motors can be used to good advantage on many other types of loads.

These new types of machines have in many applications allowed the use of a more simple motor and controller than when the conventional squirrel-cage and slip-ring types only were available. On the other hand, it is necessary that more careful consideration be given to the selection of the motor and controller to obtain the best type for a given application, all things considered.

Things One Should Know About
Petroleum and Its Products

By A. A. Potter and H. L. Solberg
Dean of Engineering, Purdue University
Ass't Prof. of Mechanical Engineering, Purdue University

PETROLEUM may be divided into three classes, depending upon the character of the residue when the oil is subjected to distillation. These divisions are:

1. Paraffin-base crudes which leave a paraffin wax on distillation.

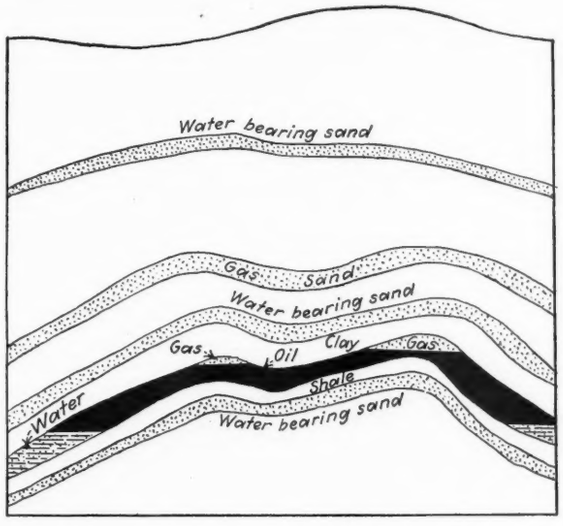


Fig. 1—Illustrates underground conditions favorable to oil and gas

2. Asphalt-base crudes which leave a black, lustrous residue of asphalt.

3. Mixed-base crudes which produce a residue that is a compound of paraffin wax and asphalt.

Paraffin-base crudes are found mainly in the East. Asphalt-base crudes are produced in California and the Gulf

TABLE I.—ANALYSES OF TYPICAL CRUDE OILS

Source of Oil	Deg. Baumé, Per Cent	Carbon, Per Cent	Hydrogen, Per Cent	Oxygen, Per Cent	Sulphur, Per Cent
California, Kern River	15	86.36	11.27	0.74	0.89
California, Sunset	14	85.64	11.37	0.84	1.06
Pennsylvania Crude	39	82.0	14.8	3.20*	....
West Virginia Crude	36	84.3	14.1	1.60*	....
Ohio Crude	28	84.2	13.1	2.7*	....
Texas Crude	22	84.6	10.9	2.87	1.63
Oklahoma Crude	25	87.93	11.47	0.19	0.41
Mexican Crude	22	83.7	10.2	....	4.15
Russia, Baku	17	86.6	12.3	1.1*	....

*Oxygen plus nitrogen.

Coast region, while the mixed-base crudes are found generally in the Mid-Continent field. Table I shows the chemical composition of a number of typical crudes.

Authorities are not in agreement as to the origin of petroleum. It may be the result of partial decomposition under water of vegetal or animal matter of marine origin, or, as some scientists believe, it may be the result of chemical reactions between inorganic substances within the earth's interior under the influence of heat and pressure. It is found in the pores of limestone or sandstone deposits, which may vary from a hard rock to a coarse sand. The quantity of oil present in a deposit will depend partly upon the porosity of the sand. The voids may be as great as 40 per cent, but if less than 10 per cent the oil cannot be recovered profitably by present methods. Fig. 1 shows typical underground conditions which are favorable for the accumulation of an oil pool. The distance from the surface of the ground to the oil-bearing sand may vary from a few hundred to several thousand feet.

Petroleum Resources

The seven major producing fields of the United States are: The Appalachian field, the Lima-Indiana field, the Illinois field, the Mid-Continent field, the Gulf Coast

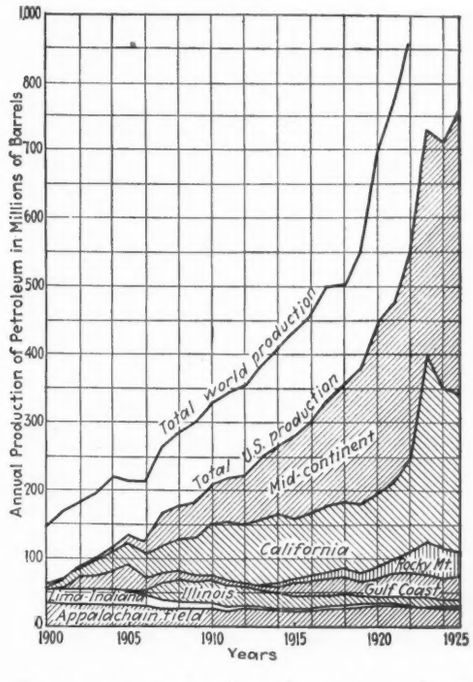


Fig. 2—Annual production of petroleum by fields; from U. S. Geological Survey

district, the Rocky Mountain district and the California field. Fig. 2 shows the annual production of each of these fields in millions of barrels.

While the United States is by far the greatest oil producing country, it actually possesses only a small fraction of the world's petroleum resources. David White, chief geologist of the United States Geological Survey,

*All rights reserved by the authors.

in the *Annals of the American Academy of Political and Social Science,* for May, 1920, states that the world's petroleum resources are between 43 and 60 billion of barrels. He estimates the maximum oil resources of the United States to be less than ten billion barrels.

An examination of the curves in Fig. 2 will show that the production in three of the seven major fields has

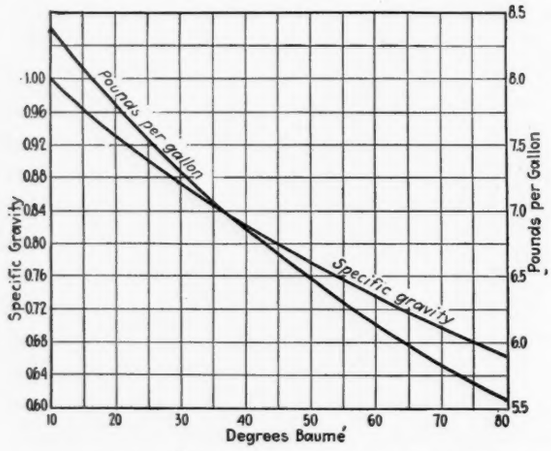


Fig. 3—Relation between degrees Baumé, specific gravity and pounds per gallon

reached a peak and has steadily declined over a period of years. These three fields have been thoroughly prospected by drilling, and it is the opinion of geologists that their possibilities have been exhausted. Production in the Gulf Coast district has been erratic, on account of the irregular discovery of new pools. Production in the Mid-Continent, California and Rocky Mountain districts is still increasing.

Some wells have a life of only a few months before they are flooded by water. Others continue to produce oil over a period of forty or fifty years. However, in nearly all cases the production falls off rapidly after a short time, so that at the end of four or five years the rate of production is but a small percentage of the production during the first year of the well.

Refined Products of Petroleum

From 65 to 95 per cent of the crude petroleum consumed in the United States is refined, the remainder being burned under boilers or in internal-combustion engines. Table II shows the proportions of the refined products that are produced.

TABLE II.—PRODUCTS OBTAINED FROM CRUDE PETROLEUM IN PERCENTAGE OF TOTAL CRUDE RUN TO STILLS

Year	Gasoline, Per Cent	Kerosene, Per Cent	Gas and Fuel Oil, Per Cent	Lubricants, Per Cent
1921.....	27.7	10.8	52.0	4.7
1922.....	29.4	11.0	51.0	4.7
1923.....	31.0	9.66	49.6	4.5
1924.....	33.0	9.3	49.7	4.2
1925.....	35.1	8.1	49.3	4.2

From "Mineral Resources of the United States."

Gasoline. Gasoline consists of hydrocarbon compounds obtained by fractional distillation of petroleum at a maximum temperature or end point of 350 to 450 deg. F. Because of increased demand there has been a gradual increase in the maximum temperature of distillation in order to increase the output. Table II shows the tendency to increase gasoline from a gallon of crude oil. This has been done partly by increasing the maximum temperature of distillation and partly by "cracking" heavier oils. The oils used for cracking are too heavy to be sold as kerosene. Under the influence of heat and pressure the heavy hydrocarbons may be decomposed into a series of lighter hydrocarbons or gasoline, a series of heavier hydrocarbons which are sold as fuel oil, and a carbon residue. From 30 to 40 per cent of the oil can thus be converted into gasoline. Gasoline produced by cracking is generally blended to produce the commercial grades.

About 10 per cent of our present gasoline supply is obtained from natural gas as "casinghead" gasoline. This is very volatile and is ordinarily blended with heavier grades.

Kerosene is a "cut" of petroleum which distills at a temperature higher than that used in producing gasoline. Once the backbone of the refining industry, kerosene is now used mainly for lighting in rural districts and for some types of internal-combustion engines. There has been a growing tendency to include the lighter fractions of kerosene in the commercial grades of gasoline and to crack the heavier fractions to produce cracked gasoline.

Fuel Oil. Fuel oil has been defined as "any petroleum product which is used for the generation of heat in a firebox." Fuel oils may be divided into the following classes:

1. Crude petroleum. Some of the crudes from the Gulf Coast district and from Mexico contain such a small amount of light oils after handling that they are burned directly without refining.

2. Residual or topped oils. During periods of over-production of crudes, "topping" plants spring into existance in order to remove the gasoline from the crude and dump the residual oil on the market in competition with

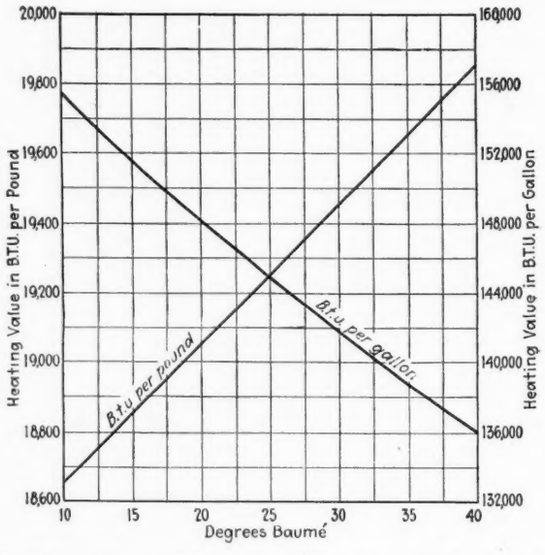


Fig. 4—Average higher heating value of dry fuel oil

coal. These skimmed oils can be handled with greater safety than the crudes.

3. Distillate fuel oils are those from which the gasoline and kerosene fractions have been distilled and which are in turn driven off from the residue which is used to make lubricating oils. They are free from ash and carbon residue.

4. Blended fuel oils. These oils are obtained by mixing the heavy residue from the refineries with lighter oils.

During periods of over-production of crudes, fuel oil is cheap because of the production of topped oils. During periods of under production, the demand for gasoline

makes it necessary to crack the lighter fuel oils and the price is correspondingly increased.

Oil as Fuel for Steam Generation

It has been estimated[1] that the ratio of coal to oil resources is in the order of 57,000 to 9¼. It is apparent, therefore, that oil cannot replace coal as a fuel for steam

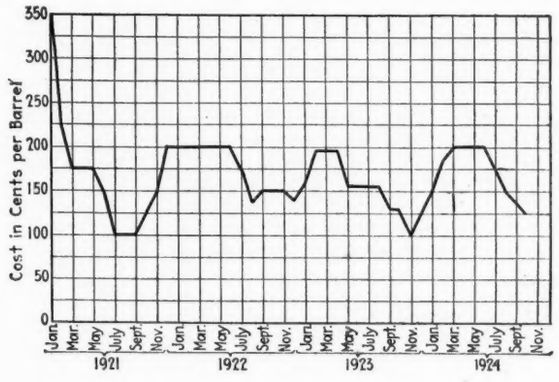


Fig. 5—Price range of Mid-Continent crude

generation. As the major producing fields are in the West and Southwest, where the supplies of good coal are limited, fuel oil is used extensively in these sections. In the industrial sections of the East and Middle West, coal is plentiful and the cost of oil is generally prohibitive. Oil has been burned to some extent along the Atlantic Seaboard where the low-grade crudes from Mexico are available. Fuel oil consumption is indicated in Table III.

Modern stationary plants can secure as good economies with coal as with oil fuel. Powdered coal possesses many

TABLE III.—FUEL OIL CONSUMPTION IN THE UNITED STATES IN 1923

	Million Barrels
Railroads	45
Steamboats	52
U. S. Navy	6
Power plants (utilities)	40
Industrial plants	125
Gas manufacture (gas oil)	22
	290

of the advantages claimed for oil, and recent improvements in mechanical stokers have resulted in boiler efficiencies that approach closely those obtained with oil fuel.

Physical Properties of Oils

Specific Gravity. Oil is sold by volume, the unit being the barrel of 42 U. S. gallons. The specific gravity is necessary for identification and for conversion from a volumetric to a gravimetric basis. It is usually determined by a Baumé hydrometer. The specific gravity can be obtained from the hydrometer reading by the following equation:

$$\textit{Specific Gravity (Am. Pet. Inst. Std.)} = \frac{141.5}{131.5 + \textit{deg Bé.}}$$

Determination of specific gravity should be made at 60 deg. F. In purchasing oil the specifications should provide that the volume be corrected to a standard temperature of 60 deg. F. The average coefficient of expansion of most oils is about 0.0004 per deg. F. Fig. 3 shows the relation between the reading of the Baumé scale, the specific gravity and the pounds of oil per gallon.

Heating Value. The higher heating value of fuel oil can be obtained experimentally by the use of a bomb calorimeter. The following equation, by Sherman and Kropff, gives results that are generally within 2 per cent of the heating value as determined experimentally:

$$\textit{B.t.u. per lb.} = 18{,}650 + 40\ (\textit{deg. Baumé} - 10)$$

The heating value of commercial fuel oils is between 18,000 and 19,500 B.t.u. per lb., with an average of 18,500 B.t.u. Fig. 4 shows the relation between the degrees Baumé and the heating value per pound, also per gallon. As liquid fuels are purchased by volume, the heavier fuels have a higher heating value than the light fuels.

Viscosity. Viscosity is measured in several ways, all of which operate on the principle of determining the time required for a definite quantity of oil at a known temperature to flow through an orifice of known size. If a Saybolt viscosimeter is used, the unit is the time in seconds required for 60 c.c. to flow through a standard orifice. The unit or degree of the Engler scale is the ratio of the time required for oil to flow through an orifice to the time required for the same quantity of water to flow through the same orifice under the same conditions. High viscosity is objectionable in an oil, as it interferes with the flow in pipes and with the atomization of the oil at the burner.

Flash and Fire Point. The flash point is the temperature at which the oil begins to give off volatile vapors that will produce a momentary flash when brought in contact with a small flame. A low flash point is relatively dangerous. United States government specifications provide that the minimum flash point of fuel oil shall be 150 deg. F. except for oils having a viscosity of more than 30 sec. at 150 deg. F. Saybolt (or 8 deg. Engler). In this case flash point shall not be below the temperature at which the oil has a viscosity of 30 seconds. This is important, as it may be necessary to heat these oils so that they can be pumped and atomized properly, and the flash point must be above the temperature to which they are heated.

The fire point is the temperature at which a heated oil evolves volatile gases at such a rate as to maintain a continuous flame at the surface when the gases are ignited. It is generally about 20 deg. F. above the flash point.

Cold Test or Pour Point. The pour point is the temperature at which the oil will congeal and refuse to flow. If the oil is to be used in a cold climate, this test is important.

Certain other physical properties are important in many cases. High sulphur content is objectionable because of its corrosive action of tanks, pipe lines and equipment. For steam generation, the sulphur content should be less than 4 per cent. A sulphur content of 2 per cent may be objectionable in metallurgical work. Most oils, with the exception of distillates, contain some moisture or ash or both. This should not be over 2 per cent. Low ash content is especially desirable if the oil is to be burned in an internal-combustion engine.

Purchase of Liquid Fuels

Fuel oil is purchased by volume, and the contract should provide that the measured volume be corrected to a temperature of 60 deg. F., using a coefficient of expansion of 0.0004. The specific gravity is often specified,

[1]Dr. George O. Smith, Director of U. S. Geological Survey, *Power*, Vol. 52, page 874.

although oils of the same specific gravity may have widely different physical properties. Since the heating value increases with specific gravity and the cost decreases with a higher specific gravity, oil of maximum gravity is desirable. Ease of handling and proper atomization depend upon viscosity; hence its inclusion in most specifications. The maximum allowable flash point is generally specified for safety in handling. It is also desirable to limit the sand, grit, water and sulphur.

The price of fuel oil is uncertain and fluctuates between wide limits. Fig. 5 shows the variation in price of Mid-Continent crude petroleum over a period of four years. Many oil-burning plants are equipped to change from oil to coal during periods of high oil prices. The resulting decrease in the demand for fuel oil has a tendency to keep the price on a competitive basis with coal. Nevertheless, the price is so uncertain that most oil companies will not sign a contract to deliver oil at a fixed price for long periods.

Storage of Oil

Storage capacity will depend upon the amount of oil burned, the number of independent sources of supply available, and reliability of supply.

Fuel oil is ordinarily stored in reinforced concrete or steel tanks. There are a few earth reservoirs in use, but the loss of oil due to seepage is appreciable. Concrete and earth reservoirs must be waterproofed. Storage should be divided between at least two tanks, so that one may be held in reserve in case it is necessary to repair the other. The tanks may be above ground or they may be buried. In either case it is convenient to design the system so that they can be filled by gravity from tank cars if the oil is received by rail.

Ordinarily, fuel oil requires heating so that it will flow, and steam connections should be provided at the railroad sidings for the coils in the tank cars. Heating coils should also be installed in the tanks at the entrance to the discharge lines. An installation of foamite, a live steam line into the top of the tank to produce a steam blanket, or some other protective device, is desirable to guard against danger from fire. Many cities have stringent regulations in regard to the storage of oil.

Natural Gas

Natural gas is usually associated with petroleum in the oil deposits. It is held in solution with the oil at the high rock pressures and is released when the pressure is relieved by the drilling of wells. Under such conditions the natural gas may contain a considerable amount of the more volatile hydrocarbons of the petroleum and is known as a "wet" gas. The so-called "casinghead" gasoline is obtained by the condensation of the vapors present in "wet" natural gas. Natural gas is often found in sand formations that are some distance from oil deposits, and in these cases it consists of fixed gases only and is called a "dry" gas. It consists mainly of methane or marsh gas (CH_4) and ethane (C_2H_6) and some inert gases such as nitrogen and carbon dioxide.

The Use of Natural Gas

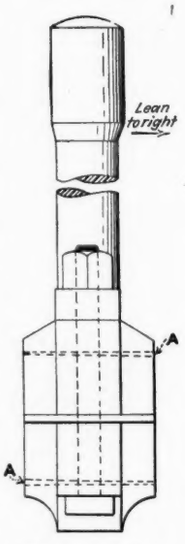
Natural gas is the ideal fuel. It is transmitted long distances through pipe lines at pressures of 200 to 400 lb. per sq.in. It is easily distributed, readily ignited and burns at a high temperature with a clean flame. It can be instantly regulated to produce any desired temperature. In the past it has been very cheap, the prices paid for it being absurd in comparison with the prices now paid for artificial gas having half the heating value of natural gas.

It has been exploited in a very wasteful manner and it is generally agreed that the resources will soon be exhausted. The rapid exhaustion of one gas field after another only serves to emphasize the fact that the days of cheap natural gas are quickly drawing to a close.

Diesel-Engine Connecting-Rod Slap

By F. C. Williams

As MOST old operators of vertical two-stroke-cycle engines know, there comes a time in the life of a connecting rod when it will not stay put, and leaving its natural position, it becomes disagreeably noisy. As there seem to be several factors in the case, it is not always easy to say which is responsible.



How to align the rod

In several cases that have come under my attention, the knot was cut by scraping the crankpin box so as to lean the rod in the direction it seemed to incline. Of course both halves must be scraped so as to maintain a running fit, else there may result a burned box. The points at which the bearings are scraped are shown at *A* in the illustration. By using good judgment and making several trials, one can obtain a fit that will enable the engine to run quietly for years. An engine may be assembled in perfect alignment, but the wear of piston, cylinder and bearing on the rod will destroy this alignment, with consequent noisy operation. After the damage has been done, it is not necessary to endure the nerve-racking noise that is heard in so many plants containing old engines, if the operator knows how to remedy the trouble without resorting to replacement, which is expensive and often inexpedient.

This hint is offered for the benefit of young engineers whose employers may be worrying them by asking what is causing the noise and who are unable to give a reply that is satisfactory to both parties.

Cutting Power Costs in a Department Store

The successful operation of a department store involves more than merchandising skill. Power-service costs have a vital influence on profits. An article in the Oct. 2 issue will show how Forbes and Wallace, Springfield, Mass., reduced power costs $5,000 yearly by installing a uniflow engine and a new boiler.

Solutions of Some Difficult Belt Drives

By J. Edgar Rhoads
J. E. Rhoads & Sons, Philadelphia

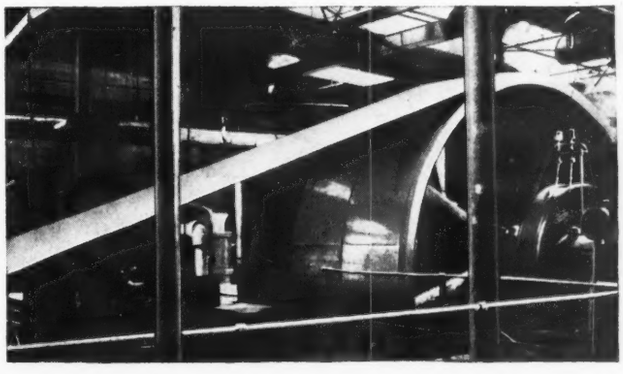
WHEN the operator of a machine is unable to get the desired production and cannot readily ascertain the trouble, it is natural with belt-driven installations to blame the belt. In the case of a valuable machine which may become jammed, serious breakage may be saved through the presence of a belt which can slip, fly off the pulley or break in such an emergency. Speed change, usually reduction, although not always, is sometimes an important factor. Therefore the belt may be performing three important functions; namely, power transmission, speed reduction and acting as a safety valve for the machine itself.

Many difficult and almost impossible belt drives come to the attention of the belt manufacturer, either by reason of complaint or by a request from some customer to help him out in a particular installation. Many such problems have come to the writer's attention, and the description of just a few typical ones may be helpful.

Case 1—This was a mixing machine in the chemical industry, where the machine is required to handle a heavy viscous product, operating about thirty minutes in one direction and then reversing and operating in the opposite direction. Thirty horsepower is required for a 500-lb. charge of the machine. With this slow draggy character of service, where the pull on the belt is high and the speed low, the belts usually have to be tightened frequently or they will not pull the load at all. The belt in this case was a 6-in. double shifting one on 16-in. driver and 48-in. driven pulley the latter running at 110 r.p.m. The belt speed was 1,380 ft. per min. and the centers about 10 ft. A number of different makes of belts were tried, none with permanent satisfaction, the best being a special tanned belt which would not carry satisfactorily a load of more than 300 lb. instead of 500 lb., the machine in this case taking about 20 hp. A combination belt was made with a tannate pulling face next to the pulleys and an oak outside ply, to give greater stiffness for shifting. This appears to have solved the difficulty by enabling them to carry 500-lb. batches of mixture in the machine. A redesign of the drive would have made it possible for lower capacity belts to do this work, but this was not convenient, hence the high pulling power and low stretch of the belt mentioned seemed to be the best solution.

Case 2—This was a group drive direct from a compound engine to a shaft driving sixteen beaters in a large paper mill. The load on the engine and belt had been increased by the addition of beaters, owing to enlargement of the mill. It was found possible to increase the capacity of the engine by raising the steam pressure to take care of the greater load, and this solution was much more economical than either putting in another engine or motorizing each beater. However, the heavy composition belt from the engine to the lineshaft would pull only 1,100 or 1,200 hp., whereas 1,700 to 2,000 hp., or possibly more at times, was desired. The belt is an open drive without an idler from a 14-ft. driving pulley on the engine. The driven pulley was 8 ft. diameter and the belt speed 4,040 ft. per min. After careful examination a 76-in. 4-ply tannate belt was recommended to replace the 76-in. composition belt. This belt it was felt would transmit more power than the drive would ever require. One point of particular interest in this drive was the tremendous tension necessary in clamp heads and rods used in making the belt endless, a pull in excess of 30,000 lb. being required. The weight of the clamps and rods used was considerably over a ton. What the ultimate capacity of this belt is will probably never be determined, as it is not likely that it ever will be loaded to its limit.

Case 3—A 200-gal. per min. portable pump handled heavy extract in a tannery. The suction lift of 8 to 10 ft. was through a $3\frac{1}{2}$ in. hose and the discharge 0 to 20 ft. through a $3\frac{1}{2}$-in. hose. A 3-hp. 1,191-r.p.m. squirrel-cage motor, fitted with a $4\frac{1}{2}$-in. diameter 4-in. face pulley, drove the pump through a belt on 24-in. chutes. The driven pulley was 24-in. Much dampness and occasional actual water or extract got on the belt. The machine manufacturer considered this installation almost impossible on account of the short centers. These were necessitated by the space in which the truck had to be man-



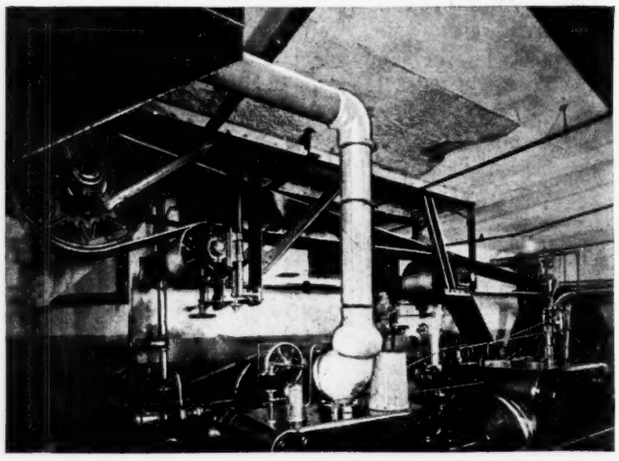
Drive mentioned in Case 2

euvered. Previously, the handling of liquor had been done by two fixed pumps of smaller capacity and using long suction and discharge hose. It was impractical to pipe to each of the 130 vats, and as frequent change of liquor was necessary, a great deal of moving of the heavy hose was required. Furthermore, hose of sufficient capacity could not be used, owing to its weight and the difficulty in moving it about.

We designed the truck and drive, recommended the type of pump and motor, and the use of a 4-in. light double tannate belt. This is now running with satisfaction and practically no attention. The total cost was

$924, which will be entirely paid for in the first six months by labor saving, and after that should show a clear gain of over $2,000 a year. This large labor saving is possible only because with the more effective and frequent pumping now possible with the portable pump, less moving of hides is required and a much larger volume of pumping accomplished. One man and a part-time helper are able to do what required three and sometimes four men.

Case 4—This was a severe compressor drive, where pressure is built up rapidly to over 2,000 lb. The compressor is a three-stage machine starting at about 100 lb.



Space limitations prevented a change in layout (Case 6)

The motor is a 40-hp. with 11¼ in. diameter pulley, driving a 66-in. pulley on the compressor. The latter operates at 128 r.p.m. and the centers between pulleys are 5 ft. 10½ in. Formerly, an idler was used on this drive to increase the arc of contact on the motor pulley. However, the best result attained was a slippage of about 3 per cent under the heaviest pressure. An 11-in. heavy double tannate belt was recommended, which was run without an idler. Even with the much reduced arc of contact on the motor pulley this belt is operating with approximately 1 per cent slip and is pumping up to the maximum pressure in less time than before.

Case 5—A centrifugal oil-clarifying machine had a vertical driven spindle turning at 15,800 r.p.m. The driving pulley on the horizontal 3,600-r.p.m. motor was 10 in. in diameter, the belt a quarter-turn, driving over one idler and tightener actuated by gravity. At this speed the centrifugal effect tending to throw the belt away from the small driven spindle pulley, 2¼-in. in diameter, is eight thousand times the weight of the mass of belt passing around the surface of the pulley. A leather belt, because of its mass, stretches excessively and therefore will not run satisfactorily. Numerous attempts to make a satisfactory fabric belt had been made with some success, but the average life of the belts was only one to two hundred hours. Our engineering department analyzed the problem with the idea of finding out exactly what was necessary to accomplish the result with satisfaction and then, after spending some months in developing special machinery, produced a type of extremely light-weight but strong woven belt, almost free from stretch. The belt is 1 in. wide, but has a breaking strength of about 800 lb. As a considerable amount of atomized oil gets on the belt, provision had to be made to resist this.

Case 6—In an ordinary power drive space limitations prevented a change of layout without great expense. Two 20-in. three-ply oak leather belts had been used with poor satisfaction, giving only four to nine months' life, and at a belt speed of a little over 2,600 ft. per min., carrying only 160 or 170 hp., whereas 225 to 275 hp. was desired. The pulleys were of fair size, and idlers were used to raise the lower strand up over the machinery, which was in the way. A 20-in. overload belt with tannate ply next the driven pulleys was recommended for the drive and has given entire satisfaction for over five years, carrying the maximum load of 275 hp.

Modernization and Higher Steam Pressures

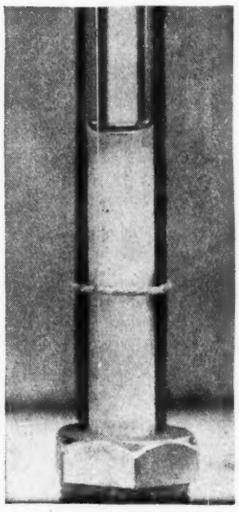
THE matter of higher steam pressures is beginning to get the attention it deserves in connection with the modernization of industrial plants. Few industries are ready to tackle 1,200 lb. at present, but boiler pressures up to 450 lb. are no longer experimental in any sense. New boilers and turbines to operate at the higher pressure can be superimposed on present plants, as has been done in certain central stations. This makes it possible to extract power from steam exhausted, or bled, to process at 150 lb., and to produce additional power from low-pressure process steam. Such an installation, now in successful operation in the Covington, Va., plant of the West Virginia Pulp & Paper Company, will be described in the Oct. 2 issue. High pressure is not the only interesting feature of this plant, which is a good all-round example of modernization in the industrial field.

Right Out of the Plant

BOILED-DOWN EXPERIENCE PASSED ALONG TO THOSE WHO MUST SAVE MONEY, IMPROVE THE PRODUCT AND KEEP THE PLANT RUNNING

A Real Water Level Device

A GREAT many home-made devices are tried to make the water in the gage glass easier to see. Some of these arrangements are good, but difficult to make. Here is a simple device used on the glass of a settling tank.



How the water looks in the glass

A thin strip of light white cardboard is laid against a piece of felt run taken from the windows of a junked automobile. The felt run is then pressed to the glass with the cardboard inside and tied as shown.

The water magnifies the white strip, giving the water-filled portion of the glass a greatly exaggerated appearance; in fact a solid block of white is seen against the sides of the strip and background. The level in the glass is easy to see even when standing a considerable distance away and there is no expense and comparatively little work in rigging the device.

F. W. BENTLEY.

Missouri Valley, Ohio.

Stator Core Bolts Cause Failure of Alternator

A 15,000-KW. 6,500-volt turbine alternator's stator winding recently broke down owing to overheating. The machine caught fire, some of the end windings being totally destroyed and the heat cracking the stator frame. No appreciable damage was done to the rotor. On examination it was found that the insulation had broken down between one of the stator-core bolts and the core. This resulted in arcing taking place along the whole length of the bolt, badly burning the laminations and welding them together.

The stator core was held together between end plates by 24 steel bolts passing through the core. These bolts were 7 ft. long and $1\frac{1}{4}$ in. in diameter and were insulated from the core by micarta tubes $\frac{1}{8}$ in. thick. After these bolts were put in place, the insulation was tested to 3,000 volts alternating current. When the machine was in operation, the induced voltage in the bolts could not have exceeded 110 volts, which, with secure insulation, should not have been objectionable.

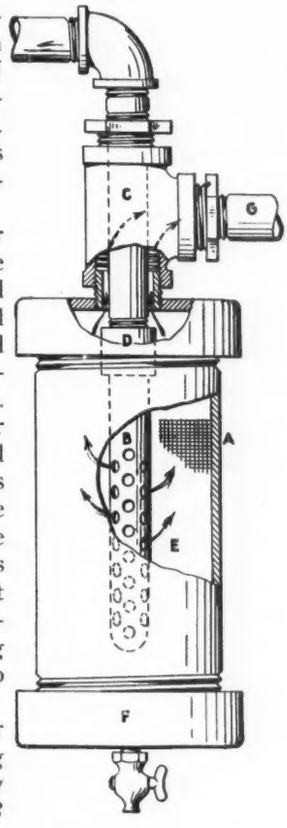
The trouble was caused by the bolts vibrating and damaging the insulation. All the bolts had their insulation damaged, but only one enough to cause a breakdown. Normally, the vibration taking place should have been negligible, but in this case the natural period of the bolts coincided with that of the machine and the resultant vibration was sufficient to damage the bolts' insulation. The frequency of vibration of the bolts depends on their length, diameter and the tension stress. The frequency of the bolts rarely coincides with that of the machine, but in this case it did, with disastrous results. The trouble was overcome by a slight alteration in design, using heavier end plates and dispensing with the core bolts.

W. E. WARNER.

Brentford, England.

Water Separator for Air Lines

IN THE use of compressed air much difficulty and expense are often occasioned by the presence of water in the air, so that many different types of separators have been devised for removing the water. In general there are two classes of air water separators, the chemical and the mechanical. In the former the presence of more or less of the absorbent or solvent material is carried away by the air, and in some uses of the air traces of this material are more objectionable than the water itself. The mechanical separation is effected by baffling, centrifugal force or otherwise.



Separator made from pipe fittings

The mechanical separator illustrated is readily made from materials usually found in power plants and has proved to be quite effective. Standard fittings and nipples are assembled substantially as shown. Nipple *B* has a capped or welded end and is perforated with holes as shown. This nipple is connected with the long threaded intake nipple *C* by the coupling *D*. Brass wire cloth is rolled to fit snugly inside the large nipple *E*, the wire cloth being inserted before the lower cap *F* is screwed on.

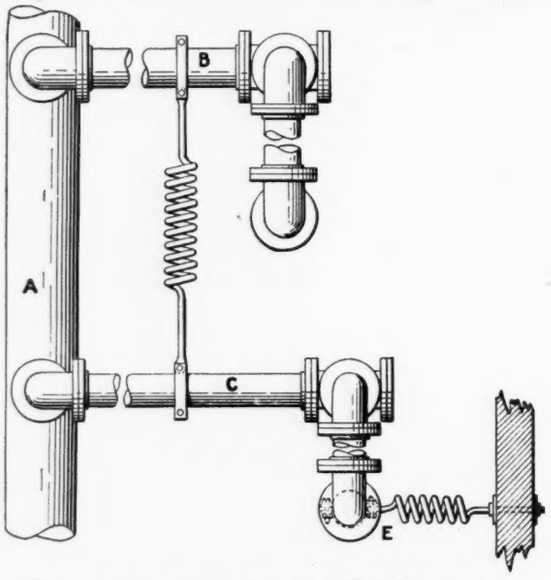
Operation of the separator is as follows: The air issuing at comparatively high velocity from the holes in nipple *B* drives the water it carries against and through the wire cloth *A* from which it runs to the lower end of the nipple *E* and is drawn off through the cock in the lower cap. The lower velocity of the air upward through the large nipple *E* facilitates the separation, and the wire cloth prevents the air from picking up the water on its way to the outlet nipple *G*.

W. L. PARKER.

Elgin, Ill.

Stopping Vibration of Steam Pipes

IN THE accompanying illustration, showing a part of the piping in our old steam power plant, *A* represents a 15-in. steam header in the boiler room and *B* and *C* 8- and 6-in. steam pipes in the engine room. These were taken off the top of the header and connected to the engines in the usual manner. The engine room was



Pipes strapped together by coiled iron rods to stop vibration

large and high and the engines were far from the steam main. The pipes were hung from the rafters, so that considerable vibration developed when the engines were running. The vibration in the horizontal runs was stopped by strapping the pipes together by coiled iron rods (not springs) to permit any necessary flexibility. Then the 6-in. drop *E* to the engine was strapped in a similar way to a near-by wall and the vibration was stopped completely. The 15-in. main was riveted pipe. Some of the joints near the 6- and 8-in. takeoffs began to leak. After the pipes had been strapped, these leaks stopped and remained tight. P. L. WILLIAMS.

Chicago, Ill.

Temperature Corrections for Baumé Gravity Readings of Fuel Oil

FUEL oil is usually purchased on a volumetric basis, from drums to tank cars, generally in terms of gallons. The usual guide for the quality of the oil, upon which the price depends, is the Baumé gravity. The higher the gravity reading the greater the value of the oil. A high-gravity oil is usually lighter in density, less viscous, cleaner, and is more easily burned.

The gravity is usually determined by placing a glass hydrometer graduated in Baumé divisions, into the oil, wherein it sinks to its equilibrium point, at which the reading is taken.

The higher the temperature of the oil the less dense it becomes, and a higher reading of the hydrometer is obtained. Hence, within limits the Baumé reading becomes a function of the temperature of the oil.

For this reason it is well worth while to watch carefully at what temperature hydrometer readings are taken, and that a standard temperature be used to which other temperatures should be corrected.

The following table is suggested for correction of American petroleum oils for Baumé readings at various temperatures:

Observed Temp., Deg. F.		Observed Baumé Gravity Readings						
		20	30	40	50	60	70	80
50	Add	0.6	0.7	0.8	1.0	1.2	1.4	1.6
52		0.5	0.6	0.7	0.8	1.0	1.1	1.3
54		0.3	0.4	0.5	0.6	0.8	0.9	1.0
56		0.2	0.3	0.3	0.4	0.5	0.6	0.6
58		0.1	0.1	0.1	0.2	0.3	0.3	0.3
60		0	0	0	0	0	0	0
62	Subtract	0.1	0.1	0.1	0.2	0.2	0.3	0.3
64		0.2	0.3	0.3	0.4	0.4	0.6	0.6
66		0.3	0.4	0.5	0.6	0.7	0.8	0.9
68		0.4	0.6	0.6	0.7	0.9	1.1	1.3
70		0.5	0.7	0.8	0.9	1.1	1.4	1.6
72		0.6	0.8	0.9	1.1	1.3	1.6	1.9
74		0.7	0.9	1.1	1.3	1.6	1.8	2.2
76		0.8	1.1	1.3	1.5	1.8	2.1	2.5
78		0.9	1.2	1.4	1.7	2.0	2.4	2.8
80		1.0	1.3	1.5	1.8	2.2	2.6	3.1
82		1.1	1.4	1.7	2.0	2.5	2.9	3.4
84		1.2	1.5	1.8	2.2	2.7	3.2	3.7
86		1.3	1.7	2.0	2.4	2.9	3.4	4.2
88		1.4	1.8	2.1	2.6	3.1	3.7	4.0
90		1.6	2.0	2.3	2.7	3.3	3.9	4.5

An example of the use of the correction table would be as follows:

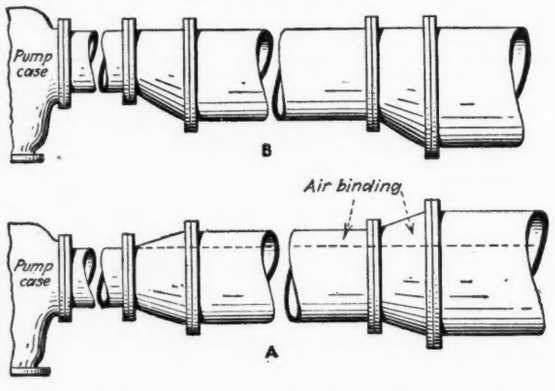
An oil is purchased and tested with a hydrometer at a temperature of 84 deg. F. and found to read 30 deg. Baumé. Since the oil is purchased on a base temperature of 60 deg. F., the true reading at 60 deg. temperature would be lower than at 84 deg. According to the table, at 84 deg. for 30 deg. Baumé oil, 1.5 should be subtracted, so that the oil should actually read 28.5 deg. Baumé at 60 deg. F. F. M. AHER.

Dayton, Ohio.

Why the Pump Capacity Dropped

A 600-GAL. per min. centrifugal pump of the double-suction type was recently installed with a very long level suction line. This line consisted of lengths of 10-in., 8-in. and 6-in. cast-iron pipe, put together so as to reduce the friction in the suction line.

Two concentric reducers were originally used, as shown at *A* in the illustration. When the pump was first



How pipe was changed to eliminate air binding

started, the full capacity of 600 gal. was received, but in an hour this was reduced to about 300 gallons.

Upon inspection it was found that the upper parts of the 8- and 10-in. pipes were airbound, owing to the concentric reducers forming a trap.

These concentric reducers were replaced by eccentric reducers, so as to keep the top line of all sizes of the pipe on the same plane, as shown at *B*. The pump immediately recovered its original capacity.

Pittsburgh, Pa. JOHN B. FOLEY, JR., Goulds Pumps, Inc.

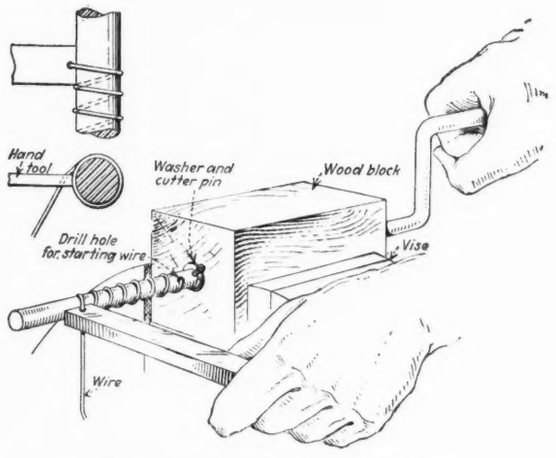
As the Other Fellow Sees It

WHERE THE MAN WHO AGREES OR DISAGREES WITH AUTHORS OR EDITORS HAS A CHANCE TO SPEAK UP

Winding Small Compression Springs

ON PAGE 157 of the July 24 issue F. R. Rawson submits a method of winding small compression springs that is somewhat akin to a method I have used with much success.

The illustration shows the apparatus, which consists of a block of wood with a hole drilled through to receive the winding arbor. This arbor may be a piece of cold-rolled steel or plain bar iron. A crank is bent on one



How Mr. Wheeler winds springs

end and two holes are drilled near the ends of the block for cotter pins, allowing space for washers. A third hole is drilled to receive the wire.

The hand tool for guiding the wire is merely a piece of flat steel having a hole drilled at an angle; this hole is slightly larger than the wire and is located from the right-hand edge of the bar a distance equal to the desired pitch of the coils. The block is gripped in the vise and the wire is passed through the holes in the hand tool and arbor. The tool is easily held in the left hand while the crank is turned with the right; as the winding proceeds, the tool will be automatically held in place and move along the bar at the same rate of travel until the spring is complete. W. L. WHEELER.

Syracuse, N. Y.

* * * *

Management in Maintenance

I SHOULD like to add a few comments to the thoughts expressed in the able editorial on page 338 of the Aug. 28 issue. The point brought out in the editorial, that more management in maintenance and less of the haphazard method of requiring equipment only when it fails to function, will not only increase production, but reduce the cost of maintenance, is one that should be seriously considered by every power-plant manager and executive.

Records and maintenance orders should be kept for every item of productive equipment that is liable to failure or improper adjustment due to wear or other causes. In addition to belting, items of equipment that should be regularly inspected, repaired and adjusted include line-shafting, bearings, fire-protection equipment, floors, stairways, safety equipment, etc.

In relation to the efficiency of the power plant, management in maintenance plays a major part. Of more importance, perhaps, than wise initial selection of equipment for power generation and distribution is the establishment of a routine that will insure all the power-generating, transmitting and power-using equipment being kept up to its orginal condition and efficiency. Boilers become scaled and dirty and their settings develop air leaks, all of which increase the coal consumption. Engine valves require adjustment from time to time and bearings need taking up. Motors may become dirty and commutators and brushes wear out. Belts stretch and become loose and must be inspected and kept up to the proper tension. Gearing will wear and requires lubrication. Neglect of any or all of these things will cause the power bill to run up. Constant vigilance and a regular system that will fix the intervals at which each item of equipment is examined and adjusted are an absolute necessity in any factory or plant where the management intends to keep power equipment at the highest point of efficiency. GEORGE H. GUNN.

Upper Darby, Pa.

* * * *

Beneficent Governmental Activity

IN THE Sept. 11 issue Charles MacCabe Smith, writing on the subject of "Beneficent Governmental Activity," invites the opinions of *Power* readers with respect to data that emanate from Washington. It is a common American attitude to evaluate things in accordance with the price paid for them. Something for nothing is looked upon with suspicion, and unless it is directly applicable to the peculiar conditions of a specific problem, it is dismissed with scant consideration. Such is the fate of much of the really valuable data promulgated from government sources at Washington.

The success of a commercial product is composed of three elements—the inherent good of the article, advertising and salesmanship. The government, obviously, cannot spend additional sums of money to advertise its free reports, or reports furnished at a nominal price. The technical press extends remarkable co-operation in this respect, but cannot advertise all government activity gratis. Government sales do not involve profits, so the chief incentive of private industry is lacking.

The reports themselves often tend by their very nature to discourage full usefulness. Prepared by personnel recruited largely directly from the technical schools, since government salaries are not generally sufficiently attractive to entice men who are successfully established in private industry, they are couched in the language and attitude of the laboratory rather than of practical industry. As a consequence the conclusions are often too involved to find direct application in industry, and empirical rules, because they are directly applicable, still

persist, although they are founded far less on facts and experimentation than are the government reports.

This condition can be greatly remedied by the co-operation of industry. The manufacturer or engineer who finds a government report useful can at least write the source, expressing his appreciation. The encouragement lent by such co-operation cannot be overestimated. If the private individual finds the report hard to apply, a detailed letter will many times secure the lacking information or will at least act as a basis for the preparation of future reports. Government reports filed away in a vault serve no useful purpose and tend to discourage the individual who has labored hard to prepare them. Comment livens up the work and supplies the much-needed practical contact and impetus for further useful activity. JOHN F. HARDECKER.

Brooklawn, N. J.

* * * *

Modern Painting Practices in the Power Plant

I READ with much interest the article by A. Davidson, entitled "Brighten Up the Boiler Room," in the Aug. 10 issue. Having had considerable experience with aluminum paint, I should like to add a few notes which may be of interest.

During the last few years increasing attention has been paid to the unique properties possessed by aluminum paint. It is fundamentally different from, and possesses singular advantages over, other pigment paints. It has a covering or hiding power excelled by no other paint, and is also an excellent protective coating for iron and steel.

The objections sometimes raised to the use of aluminum paint on radiators because of its low emissivity, are not serious, since most of the heating effect in this case results from air-convection currents. No special preparation is necessary beyond removing all dirt, grease and rust from the surface to be painted.

The durability and protective power of aluminum paint is probably due to the complete opacity and high reflectivity of aluminum, which reflects from 65 to 70 per cent of the visible spectrum and approximately 90 per cent of the infra-red rays.

Aluminum paint has a great affinity for iron and steel, but in order to obtain the best results it must be applied to the metal surfaces somewhat sparingly. Recent exposure tests on iron and steel paneling painted with aluminum paint show that the paint, when properly made and applied, is capable of protecting iron and steel under relatively severe conditions for three years and longer.

My experience with aluminum paint has shown that its efficiency depends to a great extent upon the proper leafing of the aluminum powder, hence the selection of the proper oil with which to mix the powder is important. For instance, some oils may have excellent leafing properties but are of little value from the viewpoint of durability, and consequently the use of any oil or varnish that has not been correctly prepared for use in aluminum paint is risky.

One of the most widely used is linseed oil. But raw linseed oil alone is generally unsatisfactory because the mixture is too thin in consistency with the result that the paint film runs and becomes streaky. Moreover, its drying time is much too slow for most industrial purposes. Boiled linseed oil is also too thin in consistency to give good results. However, linseed oil which has been thickened or "bodied" by heating can be successfully used, since the heat-treatment process gives the oil the consistency of varnish. A drier should be incorporated in the oil during the bodying.

According to the nature of the work two to two-and-a-half pounds of aluminum powder are required for one gallon of oil, and it will be found that a paint of this nature will prove satisfactory as a protective coating.

Aluminum paint can be made which will adhere to heated surfaces without discoloration or serious loss of adhesion. The paint should, however, be specially made if the best results are to be secured. There are a number of oils or varnishes specially treated for this purpose, and their use is recommended because of their satisfactory performance. E. ANDREWS.

Manchester, England.

* * * *

Formulas for the Notebook

IN THE May 15 issue G. F. McClay asks for an exchange of condensed formulas. I here contribute a few which are no doubt old to many *Power* readers but will be welcome to others.

1. SAFE WORKING LOAD ON CHAINS

The safe working load in tons is the diameter of the steel in the links in $\frac{1}{8}$ in., squared and divided by 10. Example: Diameter of steel in links $= \frac{5}{8}$ in., then $\frac{5^2}{10} = 2\frac{1}{2}$ tons safe load.

2. LIFT OF A VALVE

The lift of a valve to give a full opening should be one-quarter the diameter.

Example: If the diameter of the valve is $2\frac{1}{2}$ in., then the lift will $= \frac{2.5}{4} = 0.625 = \frac{5}{8}$ inch.

Proof: $\text{Lift} = \frac{\text{Area}}{\text{Circumference}} = \frac{\text{Area of } 2\frac{1}{2} \text{ in.}}{\text{Cir. of } 2\frac{1}{2} \text{ in.}} = \frac{4.909}{7.854} = 0.625 = \frac{5}{8}$ in.

3. INDICATED HORSEPOWER

$$\frac{PLAN}{33{,}000} = \text{I.Hp.}$$

P = Mean effective pressure
L = Length of stroke in feet
A = Area of cylinder in square inches
N = Number of strokes per minute in feet.

For engines of one speed P is the only item that varies, so a constant C can be found, which, multiplied by P, will give the I.Hp.

$$C = \frac{LAN}{33{,}000}$$

and $C \times P = \text{I.Hp.}$

This is very useful where a number of diagrams have to be figured.

4. TO FIND THE NUMBER OF HOLES OF SMALL DIAMETER TO EQUAL ONE HOLE OF LARGE DIAMETER

Rule: The number of times that the small diameter will go into the large diameter, squared, will equal the number of small holes required to equal the area of the large diameter.

Example: When making a screen out of a 9-in. diameter pipe, it is required to know the number of $\frac{1}{16}$-in. diameter holes that will equal the area of the 9-in. pipe.

In 9 in. there are 144 sixteenths, and 144 squared = 20,736. E. J. JORDAN.

Long Beach, Calif.

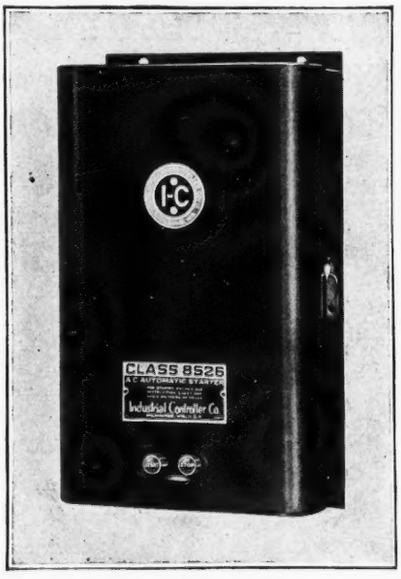
What's New in Plant Equipment

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING TRANSMITTING AND APPLYING THE POWER SERVICES

Across-the-Line Starter for A.C. Motors

A NEW series of alternating-current-motor automatic starters of the across-the-line type has been placed on the market by the Industrial Controller Company, Milwaukee, Wis. These starters provide low-voltage and either magnetic or thermal overload protection. They can be used on any type of alternating-current motor, suitable for across-the-line starting, that can be started with a 50-ampere switch.

These starters are furnished in three distinctive types. Type A has a start and a stop push button mounted in the cover, as in the figure, so that this apparatus, together with a control station, can be mounted on the machine as one unit. Type B is furnished without push button and

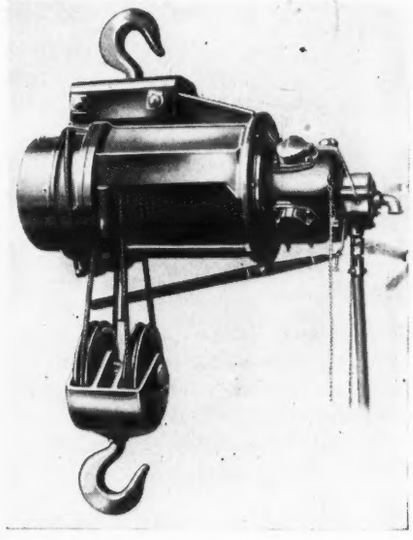


Start-and-stop push buttons in cover of the switch

is generally used where two-wire control is required together with automatic devices such as pressure switches, float switches, etc. It can also be used with a separately mounted push button in the event the starter is mounted some distance from the point of control. Type C has a three-point two-way switch mounted in the cover which provides either manual or automatic control. It is generally used with automatic devices such as float switches, pressure switches, thermostats, etc., but it also provides an additional means of starting and stopping the machine by pressing a lever manually.

Ten-Ton Capacity Air-Motor Hoist

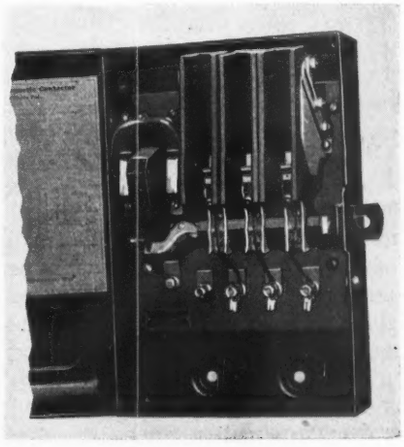
THE size G air-motor hoist illustrated, having a capacity of ten tons, has been developed by the Ingersoll-Rand Company, 11 Broadway, New York City. It employs a four-cylinder air motor geared to a rope drum, all inclosed in a compact and dustproof housing. The gears are made of special steel and heat-treated, and operate in a bath of semi-fluid grease. Either ball bearings or bronze bushings are provided where needed. The maximum lift is 16 ft., and the hoist cable is $\frac{9}{16}$ in. in diameter and 83 ft. in length. Air is conducted to the motor through a $\frac{3}{4}$-in. pipe connection. Complete control of the hoist hook movement is obtained by a graduated throttle. An automatic brake, similar to those employed in other hoists of the same manufacture, is used.



Air motor hoist of 10-ton capacity and 16-ft. lift

Magnetic Contactors for Light and Power Circuits

A COMPLETE new line of alternating-current magnetic contactors designed especially for controlling lighting and power circuits automatically, and for miscellaneous applications, is announced by the Cutler-Hammer Manufacturing Company, Milwaukee, Wis. The construction of these new contactors includes the latest developments in contactor design. High efficiency hammer-type magnets with self-aligning armature, continuous-duty magnet coil, hardened-steel bushings, tin-dipped solid-copper contacts, magnetic blowouts and chimney type arc shields are some of the outstanding features. In addition, the large-size contactors have the magnet frame supported on a spring plate which absorbs the shock of the magnet on closing.



Contactor mounted in an enclosing case

Two- or three-wire control can be used. With two-wire control, low-voltage release is provided, and with three-wire control, low-voltage protection is provided. A wide variety of types and sizes are available to fit any need. There are two-, three- and four-pole types with an ampere capacity ranging from 20 to 150 amperes. The contactors are supplied mounted in a split enclosing case, as in the figure, or on a slate panel for switchboard mounting.

Armstrong Dies for Brass Pipe

THE Armstrong Manufacturing Company, Bridgeport, Conn., has brought out a complete line of dies for brass pipe only. The dies are

Dies for brass pipe only

designed for use with the standard Armstrong stocks and are made for pipe sizes from $\frac{1}{8}$- to 2-in.

Floodlight Attachment for Acetylene Tanks

THE Prest-O-Lite Company, Inc., 30 East 42nd St., New York City, announces an improved floodlight attachment for use with small tanks of dissolved acetylene, the same as are used for truck and tractor lighting. By the connection of the attachment a convenient floodlighting unit is obtained which can be used for illumination in dark places and for facilitating night work.

The improved attachment, illustrated herewith, is of simple and compact construction. Universal adjustment is obtained with only one

Floodlight attachment

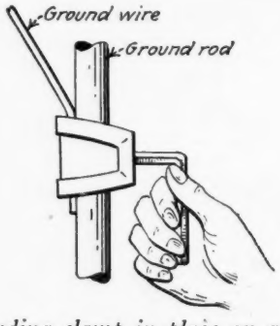
swing joint, thus minimizing the possibility of leakage.

The reflector, which is 10 in. in diameter, can be taken off by removing a single knurled nut. A new type of burner is used which it is claimed will not "carbon up" and requires no adjustment.

Ground Wire Clamp

A RECENT announcement from the Copperweld Steel Company, Glassport, Pa., tells of the development of a simple and effective grounding wire clamp. This clamp, listed as standard by the Underwriters' Laboratories, is shown in the figure. It is designed to encircle the ground rod and bind the grounding wire directly to the driven member.

With this method no solder or heat is required, it merely being necessary to pass the grounding wire into the clamp which has been placed around the driven rod, then tighten by means of a setscrew actuated by a setscrew wrench. So securely does this device clamp the wire to the driven member that the wire is flattened against the rod, thus increasing its contact surface



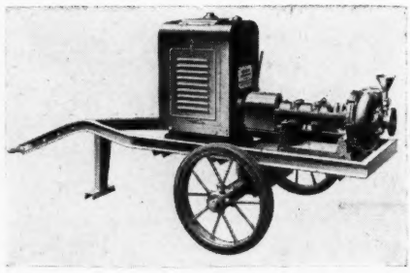
Grounding clamp in place on ground rod

and obviating the possibility of slippage. By eliminating the usual melting pot, ladle and other solder equipment, the time needed to effect the connection is materially reduced.

Portable Pumping Units of Manganese Steel

A SERIES of portable pumping units, using manganese steel for the shell, impeller and disks where shock, wear and abrasion are encountered, has been developed by the American Manganese Steel Company, Chicago. A long, ring-oiling, babbitted-sleeve bearing supports the shaft to which the impeller is press-fitted. The driveshaft is lubricated by a large oil-reservoir which also lubricates the thrust bearing. The entire unit is solidly mounted on a baseplate and is connected with a flexible coupling through a friction clutch to a Novo power unit operating at 1,200 r.p.m.

These portable pumping units are made with 2-, $2\frac{1}{2}$- and 3-in. discharge, powered by 6-, 8- and 10-hp. engines respectively. The 2-in. unit has a pumping capacity of 100 g.p.m. against a 34-ft. head with no horizontal discharge hose, and it will

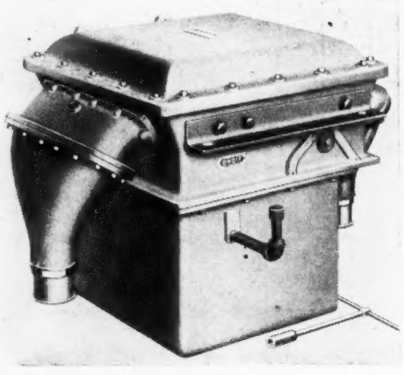


Portable pumping unit

maintain the same capacity through 125 ft. of 2 in. hose without vertical head. The $2\frac{1}{2}$-in. unit has a pumping capacity of 150 g.p.m. against a 34-ft. head with no horizontal hose, or through 150 ft. of $2\frac{1}{2}$-in. hose with no head. The 3-in. unit has an approximate capacity of 230 g.p.m. against a 37-ft. head with no horizontal hose on the discharge end. It has an equal capacity with no head and when discharging through 200 ft. of horizontal hose.

Type M-9 Manhole Oil Circuit Breaker

THE Condit Electrical Manufacturing Corporation, Boston, Mass., has brought out the manually operated manhole oil circuit breaker, illustrated, known as the type M-9, especially designed for underground



Circuit breaker for underground distribution

distribution for all voltages up to 7,500.

The breaker is of watertight construction, with reinforcing ribs at selected points, affording a rigid foundation for the mechanism contact, studs and bushings. The frame is arranged on two sides for either

single- or multi-conductor cable sleeves.

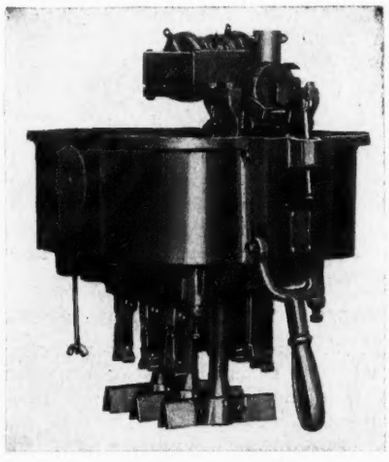
The type M-9 is furnished for automatic or non-automatic operation. For automatic operation a bushing-type current transformer and a trip coil per pole are furnished.

The breaker is furnished three-pole, for 400, 600 and 800 ampere capacity at 7,500 volts with an estimated interrupting capacity of 3,000 amperes at 7,500 volts.

New Industrial-Type Oil Circuit Breaker

THE Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., announces the new type F-10 oil circuit breaker applicable to 750- and 2,500-volt circuits and having a current-carrying capacity of 200 and 300 amperes. This breaker is furnished in two-, three- and four-pole combinations and is either automatic or non-automatic as desired. The automatic breaker has an interrupting capacity of 5,000 amperes on the 200-ampere breaker and 7,500 amperes on the 300-ampere breaker at rated voltage.

The frame, which has openings for taking leads down the two sides of the breaker or out through conduit knockouts on the sides or back of the breaker, is constructed of heavy cast iron, and arrangements are made for indoor mounting on either wall, frame or structure. The terminal board is made of moldarta, which is molded true to form, insuring correct alignment of all terminals and contacts. In addition, the moldarta extends a considerable distance up around the terminal studs of the breaker, thus giving long creepage paths between live parts.

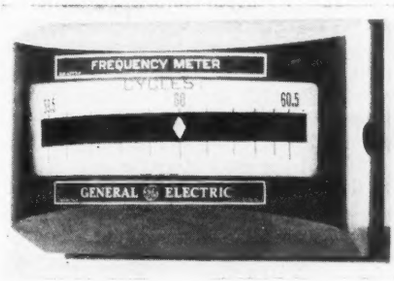


A 200-ampere breaker with cover and tank removed

Each contact of this new breaker is divided into two parts, one being the arcing portion and the other the main current-carrying part of the contact. The parts are so located that there can be no arcing on the main current-carrying part of the contact. All current-carrying parts are easily accessible and are replaceable. Standard accessories such as shunt and low-voltage trip, electric lockout and auxiliary switches can be supplied.

Frequency Meter Has High Degree of Accuracy

IN RESPONSE to the requirements for a more accurate frequency meter for power-station work, the General Electric Company has developed a new line of resonant-circuit type instruments in which full-scale range may be as small as a single cycle. The new meters are of horizontal edgewise design, as shown in the figure.



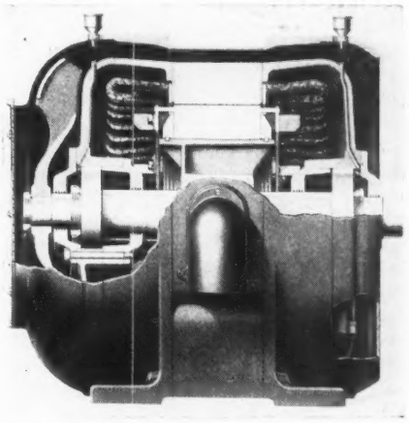
Frequency-meter range 59.5 to 60.5 cycles

The line includes five-scale calibrations, the most sensitive having a full-scale range between 59.5 and 60.5 cycles. Other calibrations are for 2, 5 and 10 cycles, arranged for service on 25-, 50-, and 60-cycle systems. All are intended for 110-volt operation.

In the design of these meters accuracy has been held of main importance. There are no appreciable voltage, wave-form or temperature errors, even when operated under extreme conditions. The resonant-circuit principle gives a deflecting torque which is proportional to the difference in the squares of the currents in two resonant circuits, and thus makes possible large deflections for small changes in frequency. A further point of accuracy is obtained by the horizontal edgewise arrangement, in that parallax between needle and scale is eliminated, permitting close readings regardless of the angle from which the meter is observed.

Totally Inclosed Fan-Cooled Motor

A NEW line of totally inclosed fan-cooled motors, rated at 1 to 50 hp., has been developed by Allis-Chalmers Manufacturing Company, Milwaukee, Wis. In this new design all the active parts, such as stator core, stator winding and the rotor, are completely inclosed, preventing contact with the outside air, dirt, dust, fumes and moisture. Heat is carried away by a sufficient volume of cooling air forced around and across those parts which conduct the heat from the interior to the outer surfaces.



A circumferential jacket controls the path of the cooling air.

A large-diameter fan, suitable for either direction of rotation, is mounted on the end of the shaft outside the bearing and a medium-mesh screen covers the air inlet.

A circumferential jacket controls the path of cooling air. Solid cast-iron bearing housings are attached to the stator end heads with machined fit, which, with grease-packed bearings, form the end closure. Internal parts of the motor are readily accessible by removal of housings. In many ratings this inclosed design delivers the same horsepower output as is obtained from the same frame in the standard open rating.

In a large number of ratings this motor is built in the same frame as the standard open-type motor of the same rating, while in practically all cases the foot height and shaft extensions are the same as for the open-frame motor, thus making the two interchangeable.

Temperature rise is within 55 deg. C measured by the resistance method. The design provides for a substantial construction with a minimum number of parts.

Second National Fuels Meeting

Held in Cleveland

Subjects Discussed Include Boilers, Gas Producers, Furnaces, Feed Water, Baffles, Refractories, Stokers and Pulverized Fuel

FROM Sept. 17 to 20 engineers gathered in Cleveland for the Second National Fuels Meeting, held under the auspices of the American Society of Mechanical Engineers, Fuels Division. Under the capable leadership of Victor J. Azbe, chairman of the division, a meeting fully as successful as that in St. Louis in 1927 was held. The topics discussed included the characteristics of coal, coal washing and preparation, firing of boilers with producer gas, the use of fuels in industrial furnaces and kilns, heat transfer, boiler water, pulverized coal, fuel research, selection of power equipment, refractories, stokers, firing of marine boilers, railway fuel practice, central-station stoker and powdered-fuel practice and smoke abatement.

President Thomas S. Baker, of Carnegie Institute of Technology, gave the opening address, after an introduction in which Chairman Azbe stressed the importance of the proper use of fuel, and a hearty welcome to Cleveland, extended by E. H. Whitlock, Smoke Commissioner of that city. Doctor Baker's topic was "The Perils and Profits of Research." Pointing out the particularly fortunate situation of the United States as to the reserves of good coal, he stressed the part this has played in the country's industrial development.

While research may, for the moment, injure certain industries, as the development of electric light at first hurt gas manufacture, its effect is good in the long run. Thus it may be stated that research is a blessing to those who profit by it and a curse to those who do not. Doctor Baker recommended that the coal industry employ research more fully as a means of combating its present troubles.

Characteristics of Coal Discussed

In one session fuel characteristics were discussed. A. C. Fieldner, Bureau of Mines, gave a paper on the "Constitution and Classification of Coal," in which he discussed the work on the classification of coals recently undertaken by the American Engineering Standards Committee, sponsored by the American Society for Testing Materials.

After reviewing what is now known of the constitution of coal, Mr. Fieldner summarized the work of classification.

Discussion of this paper, by G. E. Squires, S. B. Flagg, C. G. Estepp, W. G. Stephan, Morgan Smith and M. Silverman, brought out the fact that both producer and consumer will welcome this classification if it results in a simplification of the problem of coal purchase.

Characteristics of Different Coals

Henry Kreisinger and B. J. Cross, of the Combustion Engineering Corporation, presented a paper on "Burning Characteristics of Different Coals." After a general review of the properties of various American coals, results were given of a detailed study of what happens in the fuel bed on a grate during combustion. This study covered anthracite, Pittsburgh coke, Pittsburgh coal, lignite and lignite char. Several different firing rates were studied for each fuel, and charts were given showing the temperature and the oxygen, carbon dioxide and total combustible in the gases at distances of one to eight inches above the grates.

Discussion led by Joseph Harrington, John Hunter and John Blizard, centered largely on the use of overfire air in furnaces fired by stokers. It was brought out that sufficient air, properly mixed with the gases, is necessary to complete combustion.

Gas Producers Under Boilers

The direct firing of power boilers with producer gas was advocated by W. B. Chapman, Chapman-Stein Furnace Company, as possessing the advantages of both pulverized coal and oil without certain of their disadvantages. He would place the producer directly under the furnace, as a part of the boiler setting and thus eliminate heat losses incident to conveying the gas as well as to conserve space. That the idea is practical is attested to by the successful application of three such producers in this country and several installations in England.

Before gas producers can be made suitable for firing large boilers, changes will have to be made. Capacities must be increased up to 100 lb. per sq.ft. of grate surface per hour; the design must be altered to permit placing under the boiler; the fire beds must not require hand poking; the producers must be able to handle slack coal; and the present proportion of steam required must be greatly reduced. Considerable progress has already been made toward these ends.

In answer to an inquiry as to the ability of such a producer to handle fluctuating loads, Mr. Chapman pointed out that the large bed of coal made this easy merely by controlling the quantity of air supplied.

Industrial Furnaces

A session on industrial furnaces aroused much interest. A paper by James H. Herron, consulting engineer, Cleveland, Ohio, dealt with "Industrial Furnace Efficiency." It pointed out that, in general, coal-fired industrial furnaces have a low thermal efficiency, from 5 to 7 per cent being common. Large losses are incurred from heat in waste gases (which must exist above the work temperature), excess air, leaking of cool air at doors and during charging and unloading and through the furnace structure by conduction and radiation.

Improvements in furnace design, tending to increase efficiencies, are being made, but much is still to be desired.

Another paper given at this session, by W. E. Rice, Bureau of Mines, Pittsburgh, Pa., dealt with "The Use of Fuels in Tunnel Kilns." This was in the nature of a progress report, and pointed out the latest developments in this type of furnace, which is becoming ever more popular for industrial heating work.

Selecting Power-Plant Equipment

F. M. VanDeventer gave a paper entitled "The Determination of Economic Value in the Selection of Power Plant Equipment," in which a routine was laid down for determining which, of a number of bids, would be most economically advantageous. The point of his method is that it bases choice upon capitalized net annual saving, which is the only factor permitting of the determination of an optimum installation.

His method involves the following steps: The purchasing agent submits the bids, minus the price, to the engineers. The engineers determine the relative value of these proposals and deduce for each a figure in dollars which, when added to the bid price, gives an amount that represents the relative value of the proposal, all tangible factors considered.

"The Present Tendency of Boiler

Water Conditioning" formed the subject of an excellent paper by Dr. R. E. Hale, Pittsburgh, Pa. Its comprehensiveness does not permit of abstracting in the space available in this report, but one excerpt from the introduction warrants quoting. He says:

"The high pressures and ratings which characterize the new era of large boilers can tolerate no formation of scale without endangering continuity of operation.

"Emphasis has been placed on maintenance of conditions as the keynote of boiler-water conditioning. Since maintenance requires routine systematic testing of the boiler water, carefully taken records of any boiler plant using such control can furnish reliable daily information regarding the boiler water. Knowing those definite relations the maintenance of which represents freedom from scale and corrosion, the boiler operator by reference to his records for the preceding weeks or months can assure himself regarding the condition of the boiler surfaces at any time without taking it off the line.

Boiler Baffles

In a paper on the "Baffling of Vertical Boilers," A. C. Danks, Cleveland, Ohio, discussed the development of the cross baffle which had been undertaken with a view toward reducing draft loss and increasing output.

In the discussion of Mr. Dank's paper the heat transfer with the lowered gas velocity was questioned; also whether it is advisable to have the hot gas impinge on the rear drum or tubes at the back of the rear bank which, in this type of boiler, are not always filled with water. As to the first point, the author replied no reduction in heat transfer had been found. The second point was a matter that had been put up to the individual boiler manufacturers, some of whom believed the drum should be protected and others that no protection is necessary. Where secondary combustion is likely it is wise to protect the drum.

Pulverized Fuel Session

In a paper on "Fineness of Pulverized Fuel as Affected by Mill Types," Lincoln T. Work, Columbia University, gave the results of an investigation in which data were secured from a considerable number of typical installations.

The hammer mills, in general, produced the coarser coal, the fineness frequently being but 40 to 65 per cent through a 200-mesh sieve. There were also appreciable amounts of 60 to 100-mesh material in the samples. Microphotographs showed a scarcity of superfines, and the curves indicated variations of fineness with mill loads and wear.

Tube mills, the author found to consistently produce the finest coal. Those of the air-swept type prepared a fuel having 65 to 85 per cent through a 200-mesh screen. Both the microphotographs and turbidimeter disclosed a large quantity of superfines. Between the fineness obtained with the hammer mill and that with the tube mill lies the product of the roller mill.

In the discussion that followed, exception was taken to the author's statement of such a low percentage passing through a 200-mesh screen in the case of the hammer mill. It was further pointed out that friability of the coal and load are often as much a factor as the type of mill and that air velocities had not been considered in the comparisons.

K. Toensfeld, Combustion Engineering Corporation, reviewed the present state of the art in "Collecting Dust from Chimney Gases of Pulverized-Fuel Installations." Unfortunately there are no standard requirements set for the removal of pulverized coal ash. Therefore, the question of what constitutes a nuisance seems to be a matter of opinion, based on the volume of dust and the weight of the particles, also the extent to which the dust is diffused by winds.

The factors that enter into the selection of a dust collector are:

1, Volume and temperature of the gases; 2, grains of dust per cubic foot; 3, analysis and density of dust; 4, screen analysis; 5, relative humidity of the gases; 6, chemical analysis of the gases; 7, pressure drop through collector for normal and peak loads; 8, power requirements for normal and peak loads; 9, presence of moving parts with regard to wear; 10, capacity of collector for cleaning itself; 11, replacement and maintenance costs; 12, weight and space occupied; 13, efficiency of dust removal; 14, relative efficiency between the experimental and commercial collectors.

The author then described the various types of collectors including the Cyclone, the Mesh type, the Cinder-trap, the Vorticose, the Sirocco, the Thermix Stack and the Cottrell electrical precipitation. Test figures on several of these types were quoted, the efficiencies running as high as 98 per cent based on a 200-mesh screen and 78 per cent based on a 300-mesh screen.

Discussion of the paper brought out the influence of combustion efficiency on the dust problem. Carbon particles tend to get through the collector, and it is the amount of carbon in the dust (its color) that determines, in the eyes of the community, whether a nuisance exists. The fine dust that will pass through a 300-mesh screen is likely to be dissipated by the winds and not cause much trouble, if free from carbon. With reference to wear on fan blades, one speaker pointed out that in cement mills it has long been the practice to put the fan beyond the collector, although this is not general in power plant work.

Unit pulverizers were discussed in a paper by John Blizard, Foster-Wheeler Corporation, from the standpoint of their advantages as well as their limitations for large boilers as compared with the central system. They have the advantage of dispensing with driers, transport systems, feeders and bins. The disadvantages are difficulty of distributing the coal evenly to several burners, higher power consumption for pulverizing and lack of a large reserve supply of pulverized coal.

Since spare pulverizers would increase the cost and take up space in the boiler room, unit mills must be of heavy construction and so designed that worn parts can be renewed in a short time. They must also have means for regulation so that the fineness does not vary greatly with the load or with wear of the parts.

In order to obtain the correct mixture of coal and air at each burner, thorough mixture must occur before subdividing the stream. Should the mixture be uneven at the point of subdivision, this may be partly corrected by passing it through a cone converging in the direction of flow.

In discussing the paper, E. H. Tenney of St. Louis quoted 7.2 cents per ton maintenance with his unit mills, which is 30 per cent less than that with the big mill supplying his central system. The cost of operation is also less.

E. C. Daniels believed the air required in the unit system to be greater than with the central system; also that the flexibility is not as great.

G. C. Squire, speaking from the standpoint of the coal producer, emphasized that all coals are not satisfactory for pulverizing. He believed that much good would result through closer contact of powdered coal operators and supplying companies.

Behavior of Refractories

A paper on "Boiler Furnace Refractories," by C. F. Hirshfeld and W. A. Carter, Detroit Edison Company, described work started by the authors some four years ago and now being carried on by them under the auspices of the research committee of the A.S.M.E. This paper brought out the fact that many engineers hold misconceptions as to just what factors should be considered in judging fire-brick, while in reality, each special case must be separately considered, in the light of the present lack of knowledge concerning refractories.

Fusion temperature is not important, because the temperature in the furnace is never high enough to bring it into play. Cold crushing strength is sometimes determined, but is of no use. The temperature gradient through the walls enables the cool ends of the bricks to support the wall, though the hot ends may have reached a temperature high enough to render them incapable of bearing weight.

Spalling really occurs from many causes besides temperature changes. In fact, pinching of the brick from contraction stresses is a common cause. Also slag attacks cause spalling.

Slag erosion and blasting by fly ash and gases wear away brick, causing failures commonly attributed to fusion. Slag on walls is sometimes an advantage, but generally causes trouble.

Some think density is to be desired. It is, at times, but elsewhere a porous brick is best. However, porosity allows slag penetration, and this is bad.

Chemical analysis is at present no guide to refractory performance, though when more is known, it may be. Color means little, except as between bricks in a single batch.

In carrying out research on refractories, it will be necessary to study service conditions more fully devise tests that will indicate value and refractories that will meet conditions.

Certain facts as to refractory performance were given in the paper. Small shapes are best, because most uniform air infiltration sometimes protects the inner surface of the refractories. Common-brick backing is not good because of the different coefficients of expansion. Expansion joints clear through the wall, relieving arches, or sections of suspended wall are good practice. Keep radiant heat off walls as far as possible. Use small sections of water-cooled wall to protect refractories. And, finally, arrange for easy repair.

Discussions by Theodore Maynz and W. W. Oakley brought out among other things that cements should be of the same composition as the brick, that generally a spalling brick is better than a non-spalling, because of other properties and that present classifications of fire brick mean nothing.

Stoker Performance

A paper by Theodore Maynz, consulting engineer, Cleveland, Ohio, was entitled "Stoker Advantages and Disadvantages." The author considered hand stokers as but little better than hand firing. Overfeed, inclined and V-type stokers are adapted to low-ash, high-grade semi-bituminous coals. With other coals they are not good. For loads such as are found in hospitals, schools, and office buildings, with a proper coal, they give good service.

The natural-draft chain-grate stoker is considered obsolete. The industrial type underfeed stoker is called by the author the universal type for all small and medium-sized plants. Among the heavy-dust stokers, the multiple-retort is preferred to the forced-draft traveling-grate, although the latter has many excellent qualities and is meeting with much success where conditions are right.

This paper will be abstracted at length in a later issue of *Power*.

Discussion of the paper was lively, but the consensus of opinion was that the author was correct. Improvements in forced-draft chain grates were said to have overcome some of Mr. Maynz's criticisms. Some overfeed was said to aid the operation of underfeed stokers. The operation of forced-draft traveling-grate stokers successfully without rear arches, when selected fuels are employed, was mentioned.

At the Marine Session two papers were presented—one on "Pulverized Coal Firing of Marine Boilers," by T. B. Stillman, Babcock-Wilcox Co., and the other on "Oil Firing of Marine Boilers," by George A. Richardson, Bethlehem Steel Company.

Mr. Stillman reviewed the experiences in testing a small B. & W. marine type boiler with pulverized coal at Bayonne some time ago. The boiler was served by a ball mill feeding two turbulent type burners without preheated air and the depth of furnace was only six feet. High rates of heat liberation were attained, ranging from 45,000 to 75,000 B.t.u. per cubic foot of furnace volume per hour, but it was found desirable to keep the CO_2 down to slightly over 13 per cent in order to avoid troublesome slagging of the tubes. Slag also built up rapidly in the furnace and had to be removed every 24 hours. This slag condition was brought about by the space limitations of marine service which necessitated a short and shallow furnace.

Efficiencies of over 80 per cent were attained, and the ash at the bottom of the furnace was found practically free of carbon, although that taken from the boiler passes contained from 6 to 15 per cent, depending upon operating conditions.

Discussion raised the point as to whether it is really necessary to maintain furnace temperatures under the fusing temperature of the ash in order to avoid slagging. Some were of the opinion that this is not necessary where the furnace design permits sufficient air reaching the ash to oxidize certain of its constituents—in other words, that it is possible to "burn the ash."

Mr. Richardson dealt with the economics of oil fuel for marine work. All factors being equal it is the ideal fuel for such service, but questions of price, availability, type of vessel, cargo carrying capacity and weight, fixed charges and labor conditions, all have to be considered when deciding between fuel oil under boilers, hand firing with coal, pulverized coal and Diesel engines. At present the price of bunker coal on the Atlantic seaboard is such as to make it a serious competitor of fuel oil, whereas ships on the Pacific or plying between the east and west coasts find it advantageous to burn oil. Again, the better economy of the Diesel is largely offset in this country by the higher cost of Diesel oil over boiler oil and the higher fixed charges. With ships making long voyages the increased economy may predominate. On the other hand, owing to lower fixed charges and subsidies, many foreign ship owners find the Diesel the cheaper.

Central Station Session

J. G. Worker and J. S. Bennett, of the American Engineering Company, Philadelphia, gave a paper on "Development and Recent Design of Stoker-Fired Equipment for Steam Generation." This paper stressed the progress that has been made in stoker design and steam-generating equipment, and forecast possible future developments, chief of which was the combination of low-temperature carbonization with stokers, a development which promises greater economy of fuel use, in addition to higher thermal efficiencies.

Ten principles were laid down in the paper for the design of combustion systems.

Modern designs of multiple-retort underfeed stokers fulfilling these requirements were then discussed. H. C. Porter, E. C. Carroll, and Theodore Maynz joined in this discussion, confirming the author's reports of progress in stoker design, and the excellent results now obtained by such equipment.

E. H. Tenney presented a paper reviewing the experiences to date with pulverized coal at Cahokia, giving both performance and cost figures. This station contains both the central and unit systems. When the first boilers were installed in 1923, mills having a capacity of 6 tons per hour were the largest available. These, which were of the roller type, required 17 kw.-hr. per ton with 6 per cent moisture in the coal. Later, mills having a capacity of 15 tons an hour were installed and averaged 13 kw.-hr. per ton at full capacity. With a change to unit mills in the third section of the plant, the over-all power consumption was further reduced by the elimination of the dryer fans, the transport system and primary-air fans. Replacement of worn parts with the new mills is somewhat less expensive, the over-all maintenance being 7.2 cents per ton.

In the discussion inquiry was made as to which system at Cahokia gives the finer pulverization and as to why Belleville coal, for which the station was designed, is not burned. In reply to the first question Mr. Tenney said that it is their practice to set the large mills for a pulverization beginning at 65 per cent through a 200-mesh and for the unit mills 70 per cent. The latter are allowed to go to 55 per cent before renewal of parts. As to the second point, he stated that they have found it possible to procure a better grade of coal than Belleville at a cheaper price.

The "Present Status of Furnace and Burner Design for the Use of Pulverized Fuel," was the topic of a paper by E. G. Bailey, Fuller-Lehigh Company. The development of burners was traced up to the present turbulent design, stressing the controlling design factors of procuring intimate contact of air and fuel and of minimizing stratification in the fuel stream. Similarly, the development of furnaces was traced up to the "well" type, showing how low furnace maintenance and complete combustion of the fuel have been achieved.

At the Smoke Abatement Session, H. B. Miller reviewed the research work performed by the Mellon Institute on the damage to health, buildings, metals, and vegetation by smoke lighter than No. 3 Ringlemann. The paper by D. J. Azbe on "Smokeless and Efficient Firing of Domestic Furnaces" was followed by discussion that was unanimous on the effectiveness of steam jets over the fire and the substitution of stokers for hand firing in the elimination of smoke.

H. K. Kugel explained the methods of the Cleveland Smoke Department, indicating the types of boilers that produce smoke.

In the discussion the use of motion pictures to convince owners of smoky combustion conditions was mentioned and that constant follow-up was necessary to maintain improved conditions. It was pointed out that the lack of agreement in Ringlemann reading is often due to the background and light on the chart.

Events and Men in Power's Field

THE EDITORS WILL WELCOME THE CO-OPERATION OF READERS IN REPORTING INTERESTING HAPPENINGS, PERSONAL OR OTHERWISE

Power Engineers Hold Record Meeting at Detroit

Exhibition Attracts Large Attendance—Educational Work of N.A.P.E. Stressed—Chattanooga Chosen for Next Convention

A GOOD meeting, one of the best and largest in the history of the organization, characterized the forty-eighth annual convention of the National Association of Power Engineers, held in Detroit from Sept. 10 to 15, 1928. Business sessions were conducted with dispatch. More attention than usual was paid to education by arranging a paper or lecture for each session. Entertainment was characteristic of Detroit hospitality, and the mechanical exposition far exceeded all past efforts. For this outstanding success much credit is to be given the National Convention Committee headed by Garrett Burgess.

Headquarters were at the Hotel Statler, while the exposition and the business sessions were held in Convention Hall, the largest of its kind in the country. The final checkup gave 339 delegates, but visiting members and local engineers brought the attendance to a much larger figure. Some 40,000 to 50,000 persons were reported to have seen the exhibition. Over 440 booths on a floor space of 168,000 sq.ft. had been taken by 338 exhibitors. All varieties of modern power equipment, instruments and supplies were on display, and as interesting sidelights there were samples showing the character of the educational work conducted by the association; some Ford antiques, consisting of old-time engines, bipolar dynamos and the first Ford automobile; two speed boats, one of which was "Miss America VII," recent winner of the Harmsworth trophy, and certain exhibits of Detroit's leading product, the automobile.

T. A. Marsh, Western engineer for the Combustion Engineering Corporation, spoke on "The Engineer and the Dollar," as distinguished from the technical side of engineering. In other words, the speaker demonstrated that the engineer must build and operate his plant on the basis of commercial efficiency and must know the cost of steam production and of power if he is to anticipate an adequate return in the pay envelope.

W. B. Stout, president of Stout Air Services, Inc., talked on aëronautics, reviewing the great development of aviation in this country, commenting upon the safety of operation from the records of the Ford airport and entertaining his audience by numerous incidents from his flying experience. "The Psychological Phase of Management" was the subject presented by Thomas E. H. Black, who enlarged upon the attitude of the employee toward the manager and the effects upon production and costs.

Alex Dow, president of the Detroit Edison Company, told what part his company had played and is playing in the industrial development of Detroit. In the year he took charge, 1896, he said, the company sold 1,000,000 kw.-hr. of electrical energy at an average price of 14c. per kw.-hr., as compared to 200,000,000 kw.-hr. for the present year at an average price of 2⅓c. For this reduction a diversity of industrial load and a great increase in domestic consumption have been responsible. Industrial development has been advanced by the fact that the electrical company always has been ready to supply power, not always so much as some of the customers wanted, but to the extent to which the engineers of both companies considered economical, with due consideration for heating and steam process demands.

Entertainment consisted of an informal dance at Hotel Statler on the first evening of the meeting, a noonday luncheon in the magnificent new Masonic Temple, special entertainment by the National Exhibitors' Association, music daily in Convention Hall by the Masonic Temple Orchestra, and the grand ball in the Commandery ballroom. The latter event was separated this year from the officer installation functions and was the principal event of the meeting. The usual field day events were replaced this year by an interesting inspection trip by bus to the Fordson plant of the Ford Motor Company, and to the Airport at Dearborn. In this trip 726 participated and 116 had their first opportunity to try out the new 16-passenger planes. As an innovation, those who cared to remain until Saturday were given the opportunity for a lake ride or sight-seeing tour of the city.

Left to right—F. R. Low, John Trix and Dan Delaney. F. R. Low and John Trix have attended every convention since 1885. Dan Delaney's first convention was in 1887, and in 1895 he was elected National Treasurer, which office he held for seven successive years.

Official opening of the convention took place on Tuesday morning in the Consistory Cathedral of the Masonic Temple. Merrit C. Schwenk made the introductory remarks, and Garrett Burgess, acting as master of ceremonies, introduced the state, city and Board of Commerce executives, who welcomed the visitors and the association officials making the responses.

Among the various suggestions made

in his report, National President Bassett recommended the continuation of the Educational Department as one of the association's greatest assets, and advocated an appropriation of $10,000 to carry on the work. To reduce expenses, he favored the consolidation of the offices of the editor of the *National Engineer*, educational director, secretary, and employment bureau, and urged that the consolidated office be located in Chicago. With the principal business office of the association in Chicago, a change of the incorporation papers from New York State to the State of Illinois was recommended, to avoid the requirement of the state first mentioned of always having at least one resident director.

L. A. Pierson, chairman of the National Educational Committee, summarized the work accomplished during the year, including the publishing of four sections of the operation code, complete surveys of large plants in the power-plant cost service, the sending out of management problems, the completion of new courses in power-plant costs, electric elevators, elementary mathematics, a new short course for firemen, and a complete set of explanatory study sheets covering the use of steam tables and Mollier charts and for figuring efficiencies of engines, boilers, evaporators, centrifugal pumps, air compressors and powdered-fuel installations. Over 200 students have been started during the year, making a total of 500 men actively studying merit courses. To date about 90 men have completed courses and won their technical certificates of merit. In addition, over 150 practical certificates of merit have been issued during the year, bringing the total to about 450.

National Secretary Raven reported the formation of four new associations during the year, the reinstatement of two associations, four associations suspended and charters returned from two. Twenty-one associations had been flag winners, by showing a gain in membership of ten or more, the leader being Ohio No. 21 at Lima, with a gain of 102. Annual reports from 208 associations showed 16,328 active members as compared to 18,376 a year ago, which with delinquents, honorary and associate members, increases to a total of 19,231.

The national treasurer, S. B. Forse, gave the bank balance of Aug. 1, 1927, as $24,691.50, total receipts for the year of $65,068.75 and disbursements of $72,546.86, leaving a balance of $17,213.48.

During the general business sessions there was considerable discussion as to the value of the merit system of education, with the consensus of opinion favorable and culminating in a vote of the convention granting the requested appropriation of $10,000. Another matter requiring attention was the revision of the constitution. Connecticut No. 2 has drawn up a revised copy which, with the approval of the convention, is to be submitted to a referendum vote.

The vote to transfer incorporation papers from New York to some other state, preferably Illinois, was favorable. Other action terminated the present relations with the National Exhibitors' Association and empowered the Board of Directors to draw up new contracts with this body, establishing the National Power and Mechanical Exhibition Association, to be under the supervision of the N.A.P.E. Incoming officers for the exhibitors were announced as follows: President, I. S. Pieters; vice-president, George T. Ogden; treasurer, Fred G. Jolley; executive committee, John H. Allen, John W. Troescher, H. A. Burdorf, W. H. Gaylord, Jr., and V. B. Nickerson.

Thomas R. Herlihy, president of N.A.P.E.

Chattanooga was chosen as the next convention city. The new officers are: President, Thomas R. Herlihy, Los Angeles; vice-president, J. P. McDebilt, Philadelphia; secretary, Fred Raven, Chicago; treasurer, S. B. Forse, Pittsburgh; conductor, George Armitage, Atlantic City; doorkeeper, Charles A. Nelson, Minneapolis; trustee for five years, A. J. Diebold, Buffalo.

New Project Proposed for Tennessee River

Robert H. McNeill, a Washington attorney, has applied to the Federal Power Commission for a preliminary permit covering a large project on the Tennessee and Duck Rivers near the border between Kentucky and Tennessee. Mr. McNeill is not ready at this time to reveal the interests with which he is associated in the proposed development. He plans to construct the dam at the Aurora site, 42 miles above the mouth of the Tennessee River, creating a nine-foot navigation channel to Pickwick Landing, 206 miles up the river.

The primary power that would be made available is calculated as being 132,450 hp., provided the Cove Creek reservoir is constructed. It is proposed to install 200,000-kva. generating capacity. The Alabama Power Company has a preliminary permit covering a site at Pickwick Landing. This development would provide a navigation channel as far upstream as Muscle Shoals.

American Welding Society To Meet Oct. 8

The fall meeting of the American Welding Society this year is to be held in Philadelphia, during the week of Oct. 8 to 12. A program has been arranged and numerous papers prepared, which clearly indicate the rapid growth of this art both here and abroad. A carefully planned entertainment schedule has been worked out for the visiting ladies, and several inspection trips are projected for the members, to visit plants where welding plays a vital part in the construction of the plant or in the manufacturing processes.

The papers to be given will cover a wide range of welding subjects, including automotive and aircraft applications, factory fabrication by welding, theoretical considerations of the strength of welds, and others.

The chief highlight of the entertainment program will be the grand ball, to be held at the Benjamin Franklin Hotel on Tuesday evening, Oct. 9. In addition to this a number of sightseeing trips have been arranged for the ladies, as well as shopping excursions, bridge parties and teas, designed to occupy all the time during which society members are attending meetings. The headquarters of the convention will be the Bellevue-Stratford Hotel, in which all the technical sessions are to be held.

In connection with the convention the society will hold its annual welding exposition, which will be given as a part of the National Metal Exposition to be held at Philadelphia at that time. The exposition will include exhibits of all classes of welding equipment and applications.

Departing from the usual custom of the society, there will be no advance registration. Members may register on Monday morning, Oct. 8, either at the Bellevue-Stratford Hotel or at the Commercial Museum. Following is a detailed outline of the society's program:

TUESDAY MORNING, OCT. 9

President's address; "Welding in Heating, Ventilating and Plumbing Industry," by R. A. Jack; "Testing Joints for Aircraft Structures Prepared under Procedure Specifications," by H. L. Whittemore and H. H. Moss.

TUESDAY AFTERNOON

"Welds at Elevated Temperatures," by Prof. C. Moser; "Formula for Computing Design Stresses for Pressure Vessels," by S. W. Miller.

TUESDAY EVENING

Grand Ball, Benjamin Franklin Hotel Ballroom.

WEDNESDAY MORNING, OCT. 10

"Running a Successful Job Welding Plant," by J. S. Oechsle; "Welding in the Automobile Industry," by J. W. Meadowcroft.

WEDNESDAY AFTERNOON

Inspection trip, 2 p.m. Trips have been arranged to places of interest to

members in Philadelphia. Tentative arrangements have been made for visiting the General Electric welded building, the plant of the E. G. Budd Manufacturing Co., and an airplane plant.

THURSDAY MORNING, OCT. 11

Meeting of the Joint Pressure Vessel Committee.

THURSDAY AFTERNOON

"Design of Welded Structures," by F. P. McKibben; "Erecting a Building by Welding," by J. F. Lincoln; "Oxy-acetylene Cutting in the Structural Field," by H. E. Rockefeller.

THURSDAY EVENING

Annual banquet and dance, 6:30, Bellevue-Stratford Hotel.

FRIDAY MORNING, OCT. 12

"Design of Machinery Parts by Use of Welding of Steel Shapes," by Messrs. Hague, Marthens and Brinton.

FRIDAY AFTERNOON

Meeting of American Bureau of Welding.

FRIDAY EVENING

Meeting of Structural Steel Welding Committee.

Diesel Engine in Plane Successfully Passes Flight Test

Flight tests were successfully completed recently at the Packard proving grounds near Utica, Mich., with the first Diesel-type aircraft engine ever built. The new engine's successful demonstration, it is said, marks a revolutionary step in the development of aircraft power. The tests for the new motor were made in a regulation Stinson-Detroit monoplane. The ship was flown by Walter Lees, pilot, and Capt. L. M. Woolson, chief aëronautical engineer for the company.

The motor is of the radial air-cooled type and develops 200 hp. It represents the culmination of many years' work on the part of aëronautical engineers to adapt the Diesel principle to machines of extremely light weight. The advantages for flight purposes are of considerable importance, since the Diesel engine eliminates the use of highly inflammable gasoline fuel, and at the same time does away with the factor of unreliability presented by electric ignition systems and carburetors. Until recently, the necessity for extreme weight has kept the Diesel engine from competing with the gas engine in most of the latter's applications. Several companies, however, are now marketing light Diesels of a size and weight comparable to gasoline engines of equivalent power for service in yachts and small work boats. The news of a successful aircraft oil engine comes as a natural sequence to this innovation.

The Diesel aviation engine tested by the Packard Motor Company is notable in its simplicity, having fewer parts than even the lightest gasoline engines. Aside from the simplicity and ruggedness of the design three highly important features of the adoption of the Diesel principle are pointed out:

1. Danger of fire from gasoline is entirely removed.

2. Both fuel consumption and fuel cost are considerably reduced, it being said that the motor will carry a plane 25 per cent farther with the same weight in oil fuel as compared with gasoline.

3. Radio communication to aircraft on a broad scale will be made possible by cutting out the interference due to present electrical ignition systems on gasoline engines.

Coming Conventions

American Institute of Electrical Engineers, annual winter convention, New York City, Jan. 28-Feb. 1; annual summer convention, Swampscott, Mass., June 24-28; F. L. Hutchinson, secretary, 33 West 39th St., New York City.

American Refractories Institute, fall meeting, Pittsburgh, Pa., Oct. 24, D. A. Texter, secretary, 2202 Oliver Building, Pittsburgh, Pa.

American Society of Mechanical Engineers, Boston regional meeting, Oct. 1-3; Calvin Rice, secretary, 29 West 39th St., New York City.

American Welding Society, fall meeting at Philadelphia, Pa., Oct. 8-12; M. M. Kelly, secretary, 29 West 39th St., New York City.

Midwest Power Conference and Exhibition, at Chicago, Feb. 12-16; G. E. Pfisterer, secretary, 53 West Jackson Blvd., Chicago.

National Association Practical Refrigerating Engineers, annual convention at Louisville, Kentucky, Nov. 20-23; E. H. Fox, secretary, 5707 West Lake St., Chicago, Ill.

National Exposition of Power and Mechanical Engineering will be held at the Grand Central Palace, New York City, Dec. 3-8. Address inquiries to the International Exposition Company, Grand Central Palace, New York City.

Stoker Manufacturers Association, fall meeting at Greenbrier Hotel, White Sulphur Springs, W. Va., Oct. 22-24.

Second Bituminous Coal Conference will be held at Pittsburgh, Nov. 19-22.

World Power Fuel Conference at the Imperial Institute, London, Sept. 24 to Oct. 6.

Trade Commission Resumes Utilities Inquiries

On Tuesday, September 18, the Federal Trade Commission resumed its hearings on the propaganda phase of the utilities investigation which it has been conducting. Representatives of the National Electric Light Association, the New Jersey Electric Association and the New Jersey Public Utility Information Committee testified before the commission at the opening session.

Testimony further revealed the efforts made in opposing and preventing adverse legislation from being passed by the state legislature. It was also revealed by T. J. Grayson, treasurer of the New Jersey Electric Association and professor at the Wharton School of Finance, University of Pennsylvania, that records in which mention had been made of legislative activities had been revised so as to omit them.

Investigation of publicity methods of the Pacific coast utilities will probably take place this fall or winter, but the commission is not, at present, prepared to announce the time or other details. Likewise no date has been set for the beginning of hearings on the financial and holding company phase of the investigation. However, comprehensive questionnaires are soon to be sent out to the large holding companies.

Survey Shows Water Power Possibilities in India

Potential hydro-electric energy totaling 2,500,000 hp. is available for development in the Punjab and other districts of India, according to a report of the Trade Commissioner at Calcutta, recently made public by the U. S. Department of Commerce. In the Punjab alone, 1,770,000 kw. may be economically developed, it is estimated. At present only 8,200 kw. are under development.

The commissioner's report contains a program contemplating an electric generation and transmission system reaching from Peshawar to Delhi, to be fed from numerous hydro-electric plants located on streams flowing from the Himalaya watershed. The program, according to the commissioner, should be carried out without reference to political boundaries, to establish a system of electric power supply reaching all India.

The Punjab government has already embarked upon the construction of the first unit of the program, the development of the Uhl River. The initial station capacity is to be 36,000 kw. The commissioner believes that the demand for power in India is steadily on the increase and that a progressive carrying out of the hydro-electric program will be paralleled by wide industrial and agricultural expansion throughout the country.

N.E.L.A. Power Committee Makes Survey of Central States

An addition of 1,300,000 kw., or approximately 1,750,000 hp., to the electricity supply of the four states of Illinois, Wisconsin, Indiana and Michigan in the three years ending Dec. 31, 1927, is noted in a report of the Power Survey Committee of the Great Lakes Division of the National Electric Light Association, just made public.

This gives these four states a total energy supply of 4,556,000 kw., or about 6,100,000 hp. Approximately 10 per cent of this comes from hydro-electric stations. The remaining 90 per cent is steam-generated. The four states have nearly 17.5 per cent of the total supply of electrical energy in the United States.

The present report is supplementary to a larger and more comprehensive report issued by the committee on Dec. 1, 1925. It points out that the increase in three years is about 40 per cent and that accompanying this growth in generating capacity was a large

increase in transmission lines, carrying an abundant supply of energy into areas heretofore unserved or only partly served.

The report also notes that the increase in generating capacity was almost entirely in existing stations. One new station of major importance has been built at Powerton, on the Illinois River, just below Pekin. Its first unit of 55,000 kw. capacity is about to go into operation, and a second unit of the same capacity has been ordered.

The technical side of the report points to four principal achievements in steam central-station engineering, which have led to increased generating economies, as follows:

The large increase in the size of turbo-generator units.

The increased use of large-capacity steam boilers.

The increased use of pulverized fuel.

The increased use of higher steam pressures.

The report cites as the largest turbine on record the three-unit machine under construction for the State Line Station in Indiana, adjacent to Chicago. This turbine is rated at 208,000 kw., or about 270,000 horsepower.

R. F. Schuchardt, elctrical engineer of the Commonwealth Edison Company, Chicago, is chairman of the committee which made the survey. Prof. D. W. Mead, of the University of Wisconsin, a member of the recently appointed committee to report on the Boulder Dam project, is a member, as are also many prominent executives of electric utilities in the four states.

Safety Congress Preparations Practically Complete

Close in the wake of one of the worst natural disasters to human life and property in history—the tropical hurricane of Sept. 13 to 17—men and women from all over the United States will gather in New York City to discuss the problem of safety from every angle. The seventeenth annual Safety Congress is expected to be the largest ever held to date, as well as the most far-reaching in scope. The widespread interest aroused in this movement indicates that considerations of public and industrial safety are no longer regarded as a side issue in the affairs of the nation, but are being taken more and more seriously throughout the country.

The Congress will be under the direction of the National Safety Council, which has arranged an elaborate program of general and technical meetings covering every field in which there is risk to human life or limb. Over 110 meetings will be held under the auspices of the Council during the five days duration of the Congress. These will be distributed among five hotels, the Pennsylvania, Waldorf-Astoria, McAlpin, Martinique and Commodore. Admission to all meetings will be free, and the public is invited to attend.

The technical aspects of safety will be in charge of the American Society of Safety Engineers, whose meetings will all be held in the Pennsylvania Hotel, the first being scheduled for Tuesday afternoon, Oct. 2. The program embraces many talks by executives and safety experts of large industrial concerns, as well as discussions on the teaching of safety habits and the promulgation of the spirit of personal caution. The public utility companies will be well represented by a number of talks on many phases of accident prevention of interest to the power industry.

N. E. Funk Assistant General Manager in Philadelphia

N. E. Funk, formerly chief engineer of the Philadelphia Electric Company, has been appointed assistant general manager of that utility. During nineteen years of service Mr. Funk has been closely identified with the planning and operation of the three large generating stations, as well as with the hydro-electric plant at Conowingo.

Starting in a subordinate position, he worked his way successfully up through the ranks, gradually assuming more extensive duties. Early this year he was appointed chief engineer to succeed the late William C. L. Eglin. Mr. Funk will continue as chief engineer of the Susquehanna Power Company and the Philadelphia Electric Power Company. In addition to these activities he will serve as assistant general manager of the Philadelphia Suburban-Counties Gas & Electric Company, organized last year as a result of the merger of the Philadelphia Suburban Gas & Electric Company and the Counties Gas & Electric Company.

His early experience was with the Westinghouse Electric & Manufacturing Company and the New York Central Railroad. He has been active in the National Electric Light Association and holds membership in the American Institute of Electrical Engineers, the American Society of Mechanical Engineers and other technical associations.

Business Notes

Ford, Bacon & Davis have recently moved from 115 Broadway to 39 Broadway, New York City.

The Homestead Valve Manufacturing Company, Homestead, Pa., announces that after Oct. 1, its offices and plant will be moved to Coraopolis, Pa., where it will occupy larger quarters.

The Lincoln Electric Company, Cleveland, Ohio, has recently opened a branch sales office at 533 Market St., San Francisco, Calif. W. S. Stewart will be in charge.

Stevens & Wood have moved from 120 Broadway to 20 Pine St., New York City.

The Ross Heater & Manufacturing Company, Inc., Philadelphia, Pa., announces the opening of a branch office, also in Philadelphia, to be under the management of J. W. Spencer, Jr.

Personals

Raymond Wilcox, formerly steam power engineer in the department of engineering design of the Southern California Edison Company, has been made mechanical engineer of the steam generation department of that company. In this new capacity he will report to Frank G. Philo, superintendent of the steam generation department, and will be located at the Long Beach steam plant.

F. L. Carlisle, Chairman of the Board of Directors, Northeastern Power Corporation and Eastern States Power Corporation, has been elected president of these two companies to fill the vacancies created by the resignation of H. Edmund Machold, to become chairman of the New York State Republican Committee.

Kenneth D. Reed, formerly mechanical engineer of the Borne Scrymser Company, New York, N. Y., is now con-

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard	New York	$2.30@$2.50
Kanawha	Columbus	1.25@ 1.60
Smokeless	Cincinnati	1.75@ 2.25
Smokeless	Chicago	1.75@ 2.25
S. E. Kentucky	Chicago	1.50@ 1.75
Steam	Pittsburgh	1.40@ 1.90
Gas Slack	Pittsburgh	1.15@ 1.25
Big Seam	Birmingham	1.25@ 1.50
Anthracite (Gross Tons)		
Buckwheat	New York	$3.00
Barley	New York	1.35@ 1.75

FUEL OIL

New York—Sept. 20, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4⅜c. per gal.; 36@40 deg., furnace, tank-car lots, 7c. per gal.

St. Louis—Sept. 12, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.346 per bbl. or 42 gal.; 26@28 deg., $1.396 per bbl.; 28@30 deg., $1.446 per bbl.; 30@32 deg., $1.496 per bbl.; 32@36 deg., gas oil, 4.151c. per gal.; 38@40 deg., 5.105c. per gal.

Pittsburgh—Sept. 9, f.o.b. local refinery, 30@34 deg., fuel oil, 5⅛c. per gal.; 36@40 deg., 5⅜c. per gal.

Philadelphia—Sept. 17, 26@30 deg., $1.94@$2.01 per bbl. or 42 gal.; 13@19 deg., $0.995@$1.065 per bbl.; 22 plus, $1.52@$1.57 per bbl.; 27@30 deg., $2.14@$2.21 per bbl.

Cincinnati—Sept. 10, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5c. per gal.; 26@30 deg., 5⅛c. per gal.; 30@32 deg., 5.95c. per gal.

Chicago—Sept. 15, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 57½@ 60c. per bbl.; 26@30 deg., 75c. per bbl.; 30@32 deg., 95c. per bbl.

Boston—Sept. 17, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.425c. per gal.; 28@32 deg., 5.62c. per gal.

Dallas—Sept. 17, f.o.b. local refinery, 26@30 deg., $1.15 per bbl. or 42 gallons.

nected with the Hood Rubber Company of Watertown, Mass., as foreman of the Calender Dept.

WALTER BLOCH and A. D. FIELDS, formerly with Clark, MacMullen & Riley, Inc., New York City, announce the opening of offices as consulting engineers, specializing in industrial-plant design and equipment at 17 East 45th Street, New York, N. Y.

RALPH M. BARNES has been appointed Assistant Professor of Industrial Engineering at the State University of Iowa.

GEORGE A. ORROCK, consulting engineer, recently sailed for Europe for a seven weeks' trip, one objective of which is to attend the Fuel Section of the World's Power Conference in London. He will preside over Section K of the Conference. Mr. Orrock plans to visit the cities of Paris, Berlin and Zurich before returning to America.

TRADE CATALOGS

OIL CIRCUIT BREAKERS—The Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has recently published circular No. 1799 describing its type O-241 oil circuit breaker. This breaker is a new heavy-duty breaker built for either indoor or outdoor service on alternating-current lines. It is designed for 600, 1,200 and 2,000 amperes at 15,000 volts and 600 and 1,200 amperes at 37,000 volts.

BOILER CIRCULATORS—Under the title "Circulation," Arthur Ross, Hotchkiss & Co., Ltd., London, have recently issued an attractive 24-page booklet describing the operation of their thermo-siphonic water circulator for steam boilers. The publication includes numerous installation illustration, descriptive diagrams and charts, as well as detailed information as to the operation and value of these circulators on boilers of all types.

AUTOMATIC WELDING HEAD—In a new four-page bulletin No. GEA556B, issued by the General Electric Company, Schenectady, N. Y., a complete description is offered of a motor-driven welding head for automatic arc welding machines. The equipment is well illustrated and the description includes mention of the numerous applications of the apparatus, as well as the types of control to be used with it.

STEAM TURBINES—The Allgemeinen Elektricitats Gesellschaft, Berlin, Germany, has just issued a historical résumé of its progress in the building of large steam turbines and allied equipment. The book is in German and consists of 132 pages, profusely illustrated. In these pages are traced the development of AEG steam turbines, generators and pumping equipment during the last 25 years. The publication is titled "AEG 25-Jahre Dampfturbinen" and is issued by Otto Elsner, Berlin.

SPRAY COOLING EQUIPMENT.—Power Plant Equipment Company, 1737 Walnut St., Kansas City, Mo., has published for general distribution an attractive 24-page catalog entitled "Cooling Data and Other Information." In addition to showing the complete line of spray cooling equipment made by the company, the new publication contains information that should be of material assistance in design and layout work in connection with cooling problems. For example, charts are presented showing the relationship in condenser work between steam and water temperatures, water quantities required and the relation of the cooling range to water quantities. A pipe friction computing graph, a psychrometric table and weather statistics indicative of maximum conditions prevailing throughout the country, followed by general spray pond information give additional indication of the data available.

New Plant Construction

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

California—Yuba River Power Co., has been granted permit to construct a power development, 261,073 hp. capacity at the north and middle forks of the Yuba River. Plans include a 3,771 ft. penstock and five power houses, located near Sierra City, Downieville, Ramshorn, Garden Valley and The Narrows. Estimated cost approximately $44,000,000.

Calif., Los Angeles — R. A. Hill, 1018 Pershing Sq. Bldg., Archt. is making preliminary sketches for a 13 story apartment building including steam heating system, elevators, etc. Estimated cost $1,000,000. Owner's name withheld.

Calif., Los Angeles—N. A. Leach, 4452 Price St., will build a 27 story apartment building including steam heating and electric refrigeration systems at 8235 Sunset Blvd. Estimated cost $1,000,000.

Calif., Sacramento—Pacific Gas & Electric Co., 245 Market St., San Francisco, has been granted permit to construct a hydro-electric plant to develop, 48,068 hp. at Bear Creek on Mokelumne River here. Estimated cost approximately $7,000,000.

Calif., San Bernardino—San Bernardino County Waterworks Dist. 6, plans an election Sept. 27, to vote $50,000 bonds for waterworks improvements, including drilling of wells, installation of pumping plant, etc.

Calif., San Rafeal—City, E. W. Smith, Clk., is receiving new bids for outfall sewer and pumping plant. Former bids rejected.

Ill., Chicago — Koenigsberg & Weisfeld, 155 North Clark St., Archts., will soon award contract for an 8 story apartment building including central refrigeration plant, elevators, etc. at 546-48 Arlington Place, for S. Clifford & Co., 111 West Washington St. Estimated cost $500,000.

Ill., Chicago—J. T. Igoe, Van Buren and Jefferson Sts., awarded contract for a 10 story addition to printing plant to G. L. Arquette & Co., 180 North Michigan Ave. Estimated cost $1,200,000.

Ill., Chicago—Syndicate, c/o B. L. Steif & Co., 307 North Michigan Ave., Archts., is having plans prepared for a 20 story apartment building at 4940 East End Ave. Estimated cost $1,500,000.

Ind., Fort Wayne—St. Josephs Hospital, awarded contract for a 7 story hospital at Berry and Van Buren Sts. to M. Irmscher & Sons. Estimated cost $750,000. Steam heating system, elevators, etc. will be installed.

Ia., Cedar Rapids—Central State Electric Co., c/o John A. Reed, Gen. Mgr., plans the construction of a power dam on Des Moines River at Kalo in Memorial Park.

Ia., Cedar Rapids — City, H. F. Bloomquist, Supt. c/o City Waterworks plans filtration plant, pumping station, etc. Alvord, Burdick & Howson, 8 South Dearborn St., Chicago, Ill., are consulting engineers. This corrects report in Aug. 28 issue.

Ia., Sioux City — Cudahy Packing Co., A. F. Mills, Supt., will soon receive bids for the construction of a 54 x 146 ft. cold storage plant at stockyards. Estimated cost $200,000. Private plans.

La., New Orleans—Constructing Quartermaster, War Dept., Washington, D. C., awarded contract for the construction of a Diesel electric power plant at Fourth Mississippi River Dist. here to Busch-Sulzer Bros. Diesel Engine Co., 3300 South Second St., St. Louis, Mo. Estimated cost $21,740.

La., Shreveport — City, L. E. Thomas, Mayor, will soon award contract for the construction of an auditorium, including steam heating system, etc. at Grand Ave. and Renold St. Estimated cost $500,000. Jones, Roessle, Olschner & Weiner, Ardis Bldg. and Seymour Van Os, Merchants Bldg., are associate architects.

La., Winnfield—City is having surveys made for municipal light and water plant. Estimated cost $100,000. Swanson & McGraw, Balter Bldg., New Orleans, are engineers.

Mass., Bridgewater — Bd. of Education, State House, Boston, is having revised plans prepared for rebuilding power plant at State Normal School. Estimated cost $80,000. R. D. Kimball Co., 6 Beacon St., Boston, is engineer. Former bids rejected.

Mass., Cambridge (Boston P. O.)—City, J. J. Scully, Chn., City Hall, is receiving bids on revised plans for a pumping station at Lake View Ave. and Worthington St. Estimated cost $100,000. E. T. P. Graham, 171 Newbury St., Boston, is engineer.

Mich., Kalamazoo—Kalamazoo Stationery Co., Harrison St., awarded contract for the construction of a 50 x 50 ft. power plant on Taylor St. to O. F. Miller Co., 224 Pratt Bldg. Estimated cost $50,000.

Mich., Saginaw—Consumers Power Co., Jackson, is having plans prepared for the construction of an electric sub-station. Estimated cost $220,000. Private plans.

Minn., Baudette — City plans the construction of a municipal electric light and water plant including Diesel engines. Estimated cost $25,000.

Mo., Bismarck — City defeated election of Sept. 11 for $47,000 bonds for waterworks improvements including deep well, pump house, pumping equipment, etc. Russell & Axon, 1945 Railway Exchange, St. Louis, are engineers.

Mo., Koch — Bd. of Public Service, St. Louis, awarded general contract for addition to power plant here to Voepel Construction Co., 1113 Sidney St., St. Louis. Estimated cost $11,770.

Mo., St. Louis — Anheuser-Busch, Inc., 721 Pestalozzi St., awarded contract for the design and construction of a steam generating plant to consist of three 1,100 hp. 450 lb. boilers with superheaters, two 5,000 kw. turbines, etc. to Ophuls & Hill, Inc., 112 West 42nd St., New York, N. Y. Estimated cost approximately $1,000,000. Engineers taking bids on sub-contracts and equipment. This corrects report in Sept. 11 issue under Paducah, Ky.

Neb., Omaha—Jerpe Cold Storage Co., 12th and Douglas Sts., will soon receive bids for the construction of a cold storage plant at 1116 Douglas St. Estimated cost $50,000. J. T. Allan & N. S. Wallace, Brandeis Theatre Bldg., are engineers.

N. J., East Orange — Aetna Realty Co., H. H. Levy, 31 Wayne Ave., is having sketches made for a 10 story medical building including steam heating system,

etc. on Main St. Estimated cost $1,000,000. W. E. Lehman, 972 Broad St., Newark, is architect.

N. J., Jersey City—Bd. of Chosen Freeholders, Court House, will receive bids about Oct. 1, for the construction of an 8 story maternity hospital including steam heating, ventilation and refrigeration systems, boilers, elevators, etc. on Clifton Pl. Estimated cost $2,000,000. C. H. Ziegler, 75 Montgomery t., is architect.

N. J., Jersey City—Syndicate, c/o W. Freile, 25 Tonnelle Ave., is having plans prepared for a 10 story medical building including steam heating and ventilation systems, boilers, elevators, etc. at Tonnelle and Sip Aves. Estimated cost $1,500,000. Private plans.

N. J., Jersey City—C. Zerman, 157 Harrison St., East Orange, will build two 5 story apartment buildings including steam heating and refrigeration systems, boilers, elevators, etc. at 252-278 Harrison Ave. here. Estimated cost $1,000,000. Private plans. Work will be done by separate contracts.

N. J., Kearny—Delaware, Lackawanna & Western R.R., 90 West St., New York, N. Y., is having plans prepared for the construction of a power station on the Hackensack River here. Estimated cost $4,250,000. G. J. Ray, Hoboken, is chief engineer.

N. J., Newark—Bowman Biltmore Hotel Corp., c/o Hotel Development Service, 369 Lexington Ave., New York, is having sketches made for a 20 story hotel including steam heating system, etc. at South Broad St. and Lincoln Park. Estimated cost $1,500,000. Thomas, Martin & Kilpatrick, 1600 Walnut St., Philadelphia, Pa., are architects.

N. J., Newark—Public Service Electric & Gas Co., 80 Park Pl., is having sketches made for the construction of two electric sub-stations, one at 304-12 Norfolk St. and the other at 1223-1229 Broad St. Estimated cost $75,000 and $60,000 respectively. Public Service Production Co., 80 Park Pl., is engineer.

N. J., Ocean City—Owner, c/o G. Keister, 56 West 45th St., New York, N. Y., Archt. and Engr., is having sketches made for a 5 story hotel and pier including steam heating system, etc. on Seventh St. and Boardwalk. Estimated cost $4,000,000.

N. Y., Bayside—Knickerbocker Ice Co., 41 East 42nd St., New York, plans the construction of an ice and refrigeration plant at 223rd St. and Northern Blvd. Estimated cost $25,000. C. L. Weir, c/o owner, is engineer.

N. Y., Brooklyn—Clark Henry Corp., 119 West 40th St., New York, awarded contract for the construction of a hotel at 101 Hicks St. to Bing & Bing, 119 West 40th St. Estimated cost $2,000,000. Steam heating and ventilation systems, etc. will be installed.

N. Y., Brooklyn — Dept. of Mental Hygiene, Albany, will receive bids until Oct. 17, for remodeling pump house and power house, etc. at Brooklyn State Hospital here.

N. Y., New York—West 49th St. Construction Corp., C. H. Darmstadt, 352 West 43rd St., plans the construction of a 16 story hotel at 137 West 49th St. Estimated cost $1,250,000. H. I. Feldman, 415 Lexington Ave., is architect.

O., Akron—E. H. Weiner Co., (Commission Merchants) is having plans prepared for the construction of a commission house including refrigeration plant. Estimated cost $300,000. Wilbur Watson & Associates, 4614 Prospect Ave., Cleveland, are architects.

Tenn., Cookeville — City, F. E. Collier, Supt., will receive bids until Sept. 28, for raising dam, building power house, etc. in connection with hydro-electric plant. J. A. Switzer, Knoxville, is engineer.

Tenn., Memphis—W. C. Hedrick and R. S. Sterling, 1005 First National Bank Bldg., Ft. Worth, Tex., awarded contract for a 29 story office building at Third St. and Madison Ave. here. to Bellows-McClay Construction Co., Construction Industrial Bldg., Dallas, Tex. Estimated cost $2,000,000. Steam heating system, etc. will be installed.

Texas — Central Power Light Co., Frost Bldg., San Antonio, has closed contract with Maverick County Irrigation Dist. for water rights from Irrigation canal to be built and plans the construction of a hydro electric plant on the Canal. Estimated cost $250,000.

Va., Quantico—Bureau of Yards & Docks, Navy Dept., Washington, D. C., awarded contract for the construction of a disciplinary barracks, apartment houses, power house, etc. at Marine Barracks here to J. A. Jones Construction Co., Realty Bldg., Charlotte, N. C. Estimated cost $1,052,500.

Wash., Seattle—Dawland Maternity Inn, Inc., c/o V. W. Voorhees, Lloyd Bldg., Archt., will receive bids until Sept. 29, for the construction of first unit of maternity hospital including electric refrigeration and high and low steam pressure, elevators, etc. at Summit and University Sts. Estimated cost $300,000. Total cost $500,000.

Wash., Tacoma — City, I. S. Davison, Comr., will soon receive bids for the construction of a hydro-electric power dam and tunnel across the canyon of the north fork of the Skekomash River as second unit of Cushman power project. Plans include power house and three units of 37,000 hp. each.

Wis., Milwaukee—A. H. Seiwert, 805 36th St., Engr. is receiving bids for an 11 story office building including steam heating, ventilation and refrigeration systems, etc. on Wells St. for Medical Arts Building Co., c/o E. A. Madden, 445 Milwaukee St. Estimated cost $500,000.

Ont., Michipicoten Falls — Algoma District Power Co., Sault Ste. Marie, Ont., awarded contract for the construction of a hydro-electric plant here to Lang & Ross, Sault Ste. Marie. Estimated cost $350,000.

Ont., Toronto—T. Eaton Co., Ltd., Yonge and Queen Sts., plans the construction of a 7 story furniture store including steam heating, etc. at Yonge and College Sts. Estimated cost $2,500,000. Ross & McDonald, 1 Belmont St., Montreal, Que., are architects. Sproat & Rolph, 1162 Bay St., Toronto, are engineers.

Que., Montreal—Windsor Hotel Co. Ltd. plans the construction of a 20 story addition to hotel. Estimated cost $5,000,000.

Equipment Wanted

Boiler—Bureau of Yards & Docks, Navy Dept., Washington, D. C., boiler and accessories for Naval Operating Base (Air Station) San Diego, Calif.

Boilers—Constructing Quartermaster, Ft. Thomas, Ky., will receive bids until Oct. 2 for boilers for post gymnasium building 56.

Electrical Equipment — Dept. of Mental Hygiene, L. M. Farrington, Secy., Albany, N. Y., will receive bids until Oct. 10, for electrical equipment for two double end steel Diesel electric ferryboats for Manhattan State Hospital, Wards Island, New York City, N. Y.

Engine—Arkansas-Missouri Power Co., J. S. Painter, Local Mgr., Piedmont, Mo., will soon receive bids for a 120 hp. Fairbanks-Morse oil type engine, etc.

Engine — Bureau of Fisheries, Dept. of Commerce, Washington, D. C., will receive bids until Oct. 1, for a Diesel engine not less than 150 hp.

Engine—Farmers Gin Co., Tipton, Okla., plans the installation of a 300 hp. natural gas engine and equipment for cotton gin. Estimated cost $30,000.

Engine, Generators, Switchboard—Bureau of Yards & Docks, Navy Dept., Washington, D. C., will receive bids until Oct. 10 for oil engine, generators, switchboard, etc. at Naval Station, Guantanamo, Cuba.

Ice Machine—Pacific Seaboard Fireproof Warehouse Corp., c/o Jones & Edwards, 5880 Maywood Ave., Maywood, Calif., Archts., electric ice machine, etc. for proposed warehouse for storage of furs at O'Farrell and Beacon Sts., San Pedro, Calif.

Motors—U. S. Engineer Office, Huntington, W. Va., will receive bids until Oct. 1 for four outboard gasoline motors, etc.

Oil Burners—Superintendent of Prisons, Dept. of Justice, Washington, D. C., is receiving bids for nine oil burners for power plant at U. S. Penitentiary, McNeil Island, Wash. Former bids rejected.

Pump—City of Mangum, Okla., will receive bids until Oct. 2 for a 300 g.p.m. motor driven centrifugal pump for proposed waterworks improvements. Estimated cost $40,000.

Pump and Motor—City of Granite, Okla., plans to purchase a triplex pump and motor for proposed waterworks improvements. Estimated cost $20,000.

Pumping Equipment — City, W. J. Moore, Mayor, Mt. Vernon, Tex., will receive bids until Sept. 26 for pumping equipment, etc. for proposed waterworks improvements.

Pumps—A. L. Flint, General Purchasing Officer of Panama Canal, Washington, D. C., will receive bids until Oct. 4 for centrifugal pumps, etc.

Pumps, Etc.—Town of Nantucket, Mass., is receiving bids for pumps, etc. for proposed sewage system. Estimated cost $186,000.

Industrial Projects

Calif., Emeryville—FACTORY—Western Electric Co., 680 Folsom St., San Francisco, is having plans prepared for a 5 story factory here. Estimated cost $500,000. Private plans.

Calif., Los Angeles—CANNING PLANT—California Sanitary Canning Co., is having plans prepared for a 2 story, 165 x 400 ft. canning plant and 1 story, 165 x 190 ft. warehouse at Long Beach Ave. and 50th St. Estimated cost $100,000. H. N. Andrews, 433 Florencita Ave., Montrose, is architect.

Calif., South San Francisco—AIRPLANE FACTORY—Marchetti Motor Patents Inc Russ Bldg., San Francisco, plans the construction of an airplane factory at Bayshore Highway here. Estimated cost $300,000. A. W. Ryder, Russ Bldg., San Francisco, is architect.

Calif., South San Francisco — STEEL FACTORY — Pacific Coast Steel Co., 111 Sutter St., San Francisco, is having plans prepared for a 1 story, 160 x 500 ft. addition to factory. Estimated cost $600,000. Private plans.

Fla., Jacksonville—REFINERY—Asiatic Petroleum Co., 65 Broadway, New York, plans to expend $1,000,000 for the construction of a refinery at Phoenix Park, here.

Ill., Chicago — AUTOMOTIVE EQUIPMENT FACTORY — Indestro Co., 2650 Coyne St., awarded contract for a 2 story, 300 x 305 ft. factory for the manufacture of screw drivers, universal joints, valve lifters, drop forged hammers, etc. at 47th St. and South St. Louis Ave. to Heidel & Beck, 6235 South Michigan Ave. Estimated cost $800,000.

Ind., Indianapolis—CHAIN FACTORY—Diamond Chain Co., Kentucky Ave. and South St., awarded contract for a 1 and 4 story, 40 x 100 and 60 x 160 ft. factory to Hall Constr. Co., 406 Bd. of Trade Bldg. Estimated cost $100,000.

Ind., Indianapolis—PACKING PLANT—Hilgeneier Bros., 519 West Raymond St., awarded contract for a 3 story, 80 x 115 ft. packing plant at 519 West Raymond St. to W. P. Jungclaus, 825 Massachusetts Ave. Estimated cost $50,000.

Ind., Indianapolis — CHEMICAL FACTORY — William Lynn Co., 129 North Davidson St., will soon award contract for a 3 story, 35 x 100 ft. chemical factory. Estimated cost $46,000. L. H. Sturges, 527 Bd. of Trade Bldg., is architect.

Mich., Grand Rapids — BAKERY — Holland American Wafer Co., 1823 South Division Ave., awarded contract for a 2 story, 44 x 100 ft. bakery on South Division Ave. to Osterink & Voss, 1621 Grandville St. S. W. Estimated cost $40,000. Complete equipment will be installed.

Mich., Lansing—AUTO FACTORY ADDITION—Olds Motor Works, 1101 Division St., is having plans prepared for a 2 story, 130 x 460 ft. addition to auto factory on Division St.; also awarded contract for a 1 story, 40 x 200 ft. enameling plant to Reniger Construction Co., 127 North Cedar St. Estimated cost $350,000 and $50,000 respectively. The Austin Co., General Motors Bldg., Detroit, is engineer.

N. J., Belvidere — DYE HOUSE, etc. — Sunbury Converting Works, Sunbury, Pa., will receive bids about Oct. 1, for a dye house, finishing buildings, power plant, etc., here. Estimated cost $75,000. W. Dyer, Land Title Bldg., Philadelphia, Pa., is architect.

N. J., Elizabeth—MILL BUILDING—Hitchings Co., 1701 Spring St., (greenhouse builders) will soon award contract for a 2 story, 70 x 200 ft. mill building. Estimated cost $150,000. C. G. Poggi and W. Bragdon, 275 Morris Ave., are architects.

N. J., Jersey City—PACKING PLANT—Armour Packing Co., 120 Broadway, New York, N. Y., plans the construction of a packing plant at 17th St. between Coles and Monmouth Sts., here. Estimated cost $1,000,000. Private plans.

N. Y., Buffalo—STEEL MILL—Bliss & McLaulin Inc., Harvey, Ill., will soon receive bids for a 1 story steel mill here. Estimated cost $1,000,000. H. Carpenter, Buffalo, is engineer.

N. Y., Buffalo—AIRPLANE and MOTOR PLANT—Curtiss Aeroplane & Motor Co., 74 Kail St., plans the construction of an airplane and motor plant. Estimated cost $1,000,000.

Que., Hull—CEMENT PLANT—Canada Cement Co., E. French, Supt., plans additions to cement plant, also installation of new equipment. Estimated cost $500,000.